SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES FOR SCIENTIFIC RESEARCH.

THE development of the American university during the past twenty-five years may perhaps be regarded as the great achievement of the nation. The foundations laid at Harvard and at Johns Hopkins within the life-time of those students now profiting from them have been built upon, until we have now a score of universities, as places for research, equal to Oxford, and half a dozen rivalling those of Germany. The American college, though founded upon the English system, was of native growth, and the university based upon this college, though influenced by German methods, is distinctly national, while, at the same time, our different institutions show a marked individuality. The American university is definitely a place for research, where both teachers and students are engaged in research or in learning the methods of research. The results of the work of the students is in large measure summarized by the theses for the doctorate, and it is interesting to know what is the outcome of the past year's research.

It appears, from a somewhat careful enquiry, that eighteen leading universities conferred the Ph. D. degree on 234 candidates. The degree was not given last year by Indiana, Illinois, Kansas, Texas, Colorado, Missouri, Tulane or the Catholic University

of America. The doctorates conferred by the several universities are classified in the accompanying table:

Universities.	Humanities.	History and Economics.	Sciences.	Total.
Chicago	12	12	12	36
Yale	19	4	11	34
Johns Hopkins	11	3	19	33
Harvard	12	3	11	26
Pennsylvania	9	7	8	24
Columbia	7	5	10	22
Cornell	7	1	11	19
Clark	.....	.....	12	12
Michigan	6	1	.....	7
New York	4	.....	1	5
Wisconsin	2	1	2	5
Bryn Mawr	1	1	1	3
Leland Stanford, Jr	.....	.....	2	2
Nebraska	.....	.....	2	2
Brown	.....	.....	1	1
California	.....	.....	1	1
Columbian	.....	.....	1	1
Minnesota	1	.....	.....	1
Total number of Ph.D. degrees conferred	91	38	105	234

It is gratifying for the scientific student to note that 105 degrees were conferred in the sciences. The number of degrees in science surpasses or approximately equals the number in the humanities in all the universities except Yale, Michigan and New York, and in nearly all cases exceeds the number in history and economics. The universities vary somewhat, the sciences being relatively favored at Johns Hopkins, the humanities at Yale, and history and economics at Chicago. Princeton conferred one D. Sc., and is not included in the table. The standards of the universities vary somewhat, and it is unfortunate that in certain cases the theses are not printed. It is a sign of progress that the Ph. D. degree *causa honoris* was apparently not given last year by any important institution.

There are probably not as many as one thousand men of science in the United States engaged in original research, and the forces are consequently greatly strengthened by one hundred recruits—not including those from Germany and elsewhere—in a single year. The distribution of these students among the different sciences was as follows:

Chemistry	27
Psychology	18
Zoology	12
Mathematics	11
Physics	11
Botany	11
Geology	6
Physiology	4
Astronomy	3
Anthropology	2

The names of those on whom the doctorate was conferred for work in these sciences, and the subjects of their theses, are as follows:

THE JOHNS HOPKINS UNIVERSITY.

Cleveland Abbe, Jr.: Geology, Some Maryland Rivers and their Development: A Contribution to the Physiographic History of Maryland.

Howard Bell Arbuckle: Chemistry, A Redetermination of the Atomic Weights of Zinc and Cadmium.

Charles Gilpin Cook: Chemistry, Some Double Halides of Tin with the Aliphatic Amines and with Tetramethylammonium.

Frederick Henry Duryea Crane: Chemistry, A Contribution to the Knowledge of Tellurium.

Gilman Arthur Drew: Zoology, The Anatomy, Habits and Embryology of Yoldia Limatula, Say.

John Eiesland: Mathematics, On a Certain Class of Functions with Line-Singularities.

Charles Wilson Greene: Physiology, On the Relations of the Inorganic Salts found in Blood to the Automatic Activity of a Strip of Cardiac Muscle.

James Graham Hardy: Mathematics, On One-Variable Displacements in a Space of Four Dimensions, and on Curves of Triple Curvature.

Caleb Notbohm Harrison: Physics, The Arc-Spectra of the Elements Lanthanum, Vanadium, Zirconium.

William App Jones: Chemistry, A Contribution to the Knowledge of Dicarbonyl Cuprous Chloride.

Arthur Gray Leonard: Geology, The Basic Rocks of Northeastern Maryland and their Relation to the Granite.

Charles Elwood Mendenhall: Physics, A Bolomet-

ric Study of the Spectrum of an Absolutely Black Body between the Temperature of 300° to 1100° Centigrade.

Samuel Alfred Mitchell: Astronomy, I. The Theory of the Concave Grating; II. Use of the Concave Grating in Stellar Spectroscopy.

Cleophas Cisney O'Harra: Geology, The Geology of Alleghany County, Maryland.

Thomas Dobbin Penniman: Physics, Some new Methods for the Determination and Comparison of Self Inductance, Mutual Inductance and Capacity, together with some Actual Measurements.

Edward Rhoads: Physics, The Effect of the Fibrous Structure of Sheet Iron on the Changes in the Length accompanying its Magnetization.

Garnett Ryland: Chemistry, A Contribution to the Study of Liquid Mixtures of Constant Boiling Point.

Charles William Waidner: Physics, A Recalculation of the Mechanical Equivalent of Heat.

Albert Francis Zahm: Physics, Determination of the Resistance of the Air at Speeds of 200 to 500 Miles an Hour, with Notes on two New Methods of Measuring Projectile Velocities inside and outside the Gun.

UNIVERSITY OF CHICAGO.

Samuel Jackson Holmes: The Early Development of Planorbis trivolvis.

Henry Chandler Cowles: An Ecological Study of the Sand Dune Flora of Northern Indiana.

Herbert Ellsworth Slaught: The Cross Ratio Group of 120 Quadratic Cremona Transformations of the Plane.

William L. Bray: The Xerophytic Flora of the Texan Plains.

Otis William Caldwell: Morphology of Lemna, with Ecological Notes.

Otto Knute Olaf Folin: On Urethanes.

Edwin Sheldon Johonnot, Jr.: Thickness of the Black Spot in Liquid Films.

Herbert Newby McCoy: On the Hydrochlorides of Carbophenylimide Derivatives.

William Dayton Merrell: Contribution to the Life History of Silphium.

Amy Eliza Tanner: Imagery, with Special Reference to Association of Ideas.

William Douwes Zoethout: The Physiological Effects of High Temperatures and Lack of Oxygen upon Lower Organisms.

CLARK UNIVERSITY.

Frederick C. Ferry: Mathematics, Geometry on the Cubic Scroll of the First Kind.

Ernest W. Rettger: Mathematics, On Lie's Theory of Continuous Groups.

Benjamin F. Sharpe: Physics, An Instrument and Method for the Measurement of Sound.

Frederick L. Burk: Psychology, From Fundamental to Accessory in Nerve-Muscle Structure and Function.

F. E. Bolton: Psychology, Some Hydro-psychoses.

Linus W. Kline: Psychology, Migration *vs.* Love of Home.

J. Richard Street: Psychology, A Genetic Study of Immortality.

Daniel E. Phillips: Psychology, The Teaching Instinct.

F. W. Colegrove: Psychology, Memory as a Function of Age.

E. W. Bohannan: Psychology, Motor-Education.

Cephas Guillet: Psychology, Instincts in Children and Animals Compared.

H. S. Curtis: Psychology, Inhibition Experimentally and Theoretically Considered.

CORNELL UNIVERSITY.

Samuel Jackson Barnett: On the Surface Tension of Liquids under the Influence of Electrostatic Induction.

Isaac Madison Bently: The Qualitative Fidelity of the Memory Image.

Hector Russell Carveth: Single Differences of Potential.

Charles Worthington Comstock: The Application of Quaternions to the Analysis of Internal Stress.

Benjamin Minge Duggar: Studies on the Morphology of the Gametophyte, and Development of the Sporangium, in some Angiosperms.

Eleanor Acheson McCulloch Gamble: The Applicability of Weber's Law to Smell.

Cyril George Hopkins: The Chemistry of the Corn Kernel.

James George Needham: A Genealogic Study of Dragon-fly Wing Venation.

Stella Emily Sharp: Individual Psychology.

John Ferguson Snell: Potassium Chloride in Aqueous Acetone.

HARVARD UNIVERSITY.

Frank Watts Bancroft: Zoology and Physiology, Ovogenesis in Distaplia with Remarks on other Species.

Harry Yandell Benedict: Celestial Mechanics, The Variation of Latitude.

William Burdelle Bentley: Organic Chemistry, Tribrombenzol and Derivatives.

Joseph William Blankinship: Botany, Isolation as a Criterion of Species.

Donald Frank Campbell: Mathematics, On Linear Differential Equations of the Third and Fourth Orders, in whose Solutions exist certain Homogeneous Relations.

Allerton Seward Cushman: Chemistry, The Atomic Weight of Nickel.

James Edwin Lough: Psychology, The Intensity of Sensation: An Experimental Essay in Physiological Psychology.

Frank Russell: Somatology, A Study of a Collection of Eskimo Crania from Labrador, with Observations on the prevailing System of Craniometry.

Charles Augustus Soch: Organic Chemistry, Action of Sodium Nitromalonic Aldehyde on Ketones and Ketone Acids.

Leon Mendez Solomons: Psychology, The Fusion of Touch Sensations.

Frederick Clayton Waite: Zoology, The Structure and Development of the Antennal Glands in Homarus americanus Milne-Edwards.

YALE UNIVERSITY.

Alice Hopkins Albro: Chemistry, The Original and Chemical Relationship of some Products of Proteolytic Cleavage.

Martha Austin: The Estimation of Manganese in Analysis.

Bayard Barnes: Chemistry, Investigations in Organic Chemistry.

George Francis Eaton: The Prehistoric Fauna of Block Island, as indicated by its Ancient Shell Heaps.

Harry Ward Foote: Investigations in Chemistry and Mineralogy.

Yandell Henderson: Chemico-Physiological Studies on the Derivatives of the Proteids.

George Tucker Sellew: On the Complex Number.

George Pratt Starkweather: The Thermodynamic Relations for Water Steam.

Wendell Melville Strong: On the Necessity of Continuity in Euclid's Geometry.

Willard Gibbs Van Name: On the Embryology of a Marine Planarian.

Jacob Westlund: Some new Equations of Transformation.

COLUMBIA UNIVERSITY.

Gary Nathan Calkins: Zoology, Mitosis in Noctiluca Miliaris and its Bearing on the Nuclear Relations of the Protozoa and Metazoa.

Wilber Dwight Engle: Chemistry, Some Thiocyanates.

Abel Joel Grout: Botany, A Revision of the North American Isotheciaceæ and Brachytheciæ.

Marshall Avery Howe: Botany, The Hepaticæ of California.

Wilfrid Lay: Psychology, Mental Imagery.

Albert Prescott Matthews: Physiology, The Structural Changes of the Pancreas Cell, with some General Considerations on Cell Metabolism.

John Alexander Matthews: Chemistry, On the Action of Fatty Nitrils upon Aromatic Acids.

Per Axel Rydberg: Botany, A Revision of the North American Potentilleæ.

Frank Schlesinger: Astronomy, The Præsepe Group; Measurement and Reduction of the Rutherford Photographs.

Edward Lee Thorndike: Psychology, Animal Intelligence.

UNIVERSITY OF PENNSYLVANIA.

Elizabeth Allen Atkinson: Metal Separations by Means of Hydrobromic Acid Gas: Indium in Tungsten Minerals.

Frederick Ehrenfeld: A Study of the Igneous Rocks of York Haven and Stony Brook, Pa., and their Accompanying Formations.

William Mason Grosvenor, Jr.: Electrolytic Reductions.

Harold Heath: The Development of Ischonochiton.

Victor Lenher: The Atomic Mass and Derivatives of Selenium.

Joseph Merritt Matthews: Derivatives of the Tetrahalides of Zirconium, Thorium and Lead.

Edward Anson Partridge: On the Mathematical Theory of the Geometric Chuck.

George William Sargent: The Quantitative Determination of Boric Acid in Tourmaline.

George Edward Thomas: The Atomic Mass of Tungsten and the Preparation of Sodium Pertungstate by means of the Electric Current.

LELAND STANFORD, JUNIOR, UNIVERSITY.

George Clinton Price: Development of the Excretory Organs of a Myxinoid, Bdellostoma Stouti.

Walter Robert Shaw: Observations on the Fertilization of the Egg-cell in the genus *Onoclea*.

UNIVERSITY OF NEBRASKA.

Frederic Edward Clements: The Phyto-geography of Nebraska.

Albert Luther Candy: A General Theorem relating to Transversals and its Consequences.

UNIVERSITY OF WISCONSIN.

Ernest Robertson Buckley: Geology, The Building and Monumental Stone of Wisconsin.

Samuel Weidman: Geology, The Geology of the pre-Cambrian Igneous Rocks of the Fox River Valley, Wisconsin.

BROWN UNIVERSITY.

Frederic Slocum: The Harmonic Analysis of the Tides and a Discussion of the Tides of Narragansett Bay.

BRYN MAWR COLLEGE.

Esther F. Byrnes: Morphology, The Maturation and Fertilization of the Egg of Limax.

UNIVERSITY OF CALIFORNIA.

Willis Linn Jepson: Botany, Flora of Western Middle California.

COLUMBIAN UNIVERSITY, WASHINGTON, D. C.

Cabell Whitehead: Chemistry, A Study of the Tellurides: their Formation and Chemical Properties.

NEW YORK UNIVERSITY.

William Lawrence A. Dalton: Psychology, Experimental Studies in Association and Memory.

THE BEGINNINGS OF LABORATORY TEACHING IN AMERICA.

THE American Association for the Advancement of Science celebrates this year its fiftieth anniversary. The epoch thus commemorated is notable in more than one way as that of a scientific awakening in this country. The foundation of the Association; the welcome given to Agassiz, whose first lectures were delivered at the Lowell Institute in 1846; the enthusiasm greeting the astronomical pilgrimages of O. M. Mitchell, to quote but a few out of many indications, show an aroused public sentiment with regard to natural science.

In no way is this movement more striking than in the effect upon scientific teaching in the colleges. For many years this had been nearly at a standstill. The methods seem to have been everywhere much the same. Instruction was by text-book and lecture. The lectures were illustrated, the illustrations of the spectacular sort. The magnitude or brilliancy of a lecture experiment was often as highly valued as its actual illustrative character. Thus the compound blowpipe and the mammoth batteries of Robert Hare were eagerly welcomed by Benjamin Silliman, with a keen appreciation of effects, and he points with a just pride to the hugeness of the electromagnet constructed for Yale College under the direction of Joseph Henry.

The Yale catalogue of 1822 announces that "The junior class attends a course of experimental natural philosophy; and the senior class the courses in chemistry, mineralogy, geology and the principles of natural philosophy."

All these courses were under the charge of Professor Silliman, and the above formula remains practically unchanged in the catalogues for upwards of twenty-five years, or until after the founding of the Scientific School. Other college catalogues, Amherst, Bowdoin, Brown, Harvard, Princeton, tell a similar story.

At Dartmouth, as at Yale, the necessity of providing for medical students required the maintenance of a somewhat high scientific standard, and a brief summary of the progress of chemical teaching at Dartmouth probably gives an idea of the best opportunities of the day.

Lectures on chemistry were given at Dartmouth before the opening of the present century, the lecturer holding the double title—varying somewhat from year to year—of professor (or lecturer) on chemistry and medicine.

In 1820 James Freeman Dana is professor of chemistry, mineralogy and the application of science to the arts; in 1822 professor of chemistry, mineralogy, pharmacy and legal medicine. The number of departments under control of one man sufficiently indicates the paucity of the courses.

In 1825 Professor Dana published an 'Epitome of Chemical Philosophy.' This appears to be the first mention of a text-book in chemistry, though these were probably in use before. In 1833 Turner's Chemistry was used, and then successively Kane's, Fownes' and Silliman's. Through much of this period a small fee is charged students attending the chemical lectures, which are given in connection with the text-book.

In the catalogue for 1851–52 the statement is made that 'the chemical laboratory is amply furnished with apparatus and chemicals *for illustration of lectures in that*

department.' The founding of the Chandler Scientific School at this period put the teaching of science on an entirely different plane.

Like conditions prevailed everywhere. The spirit of investigation showed itself actively enough in some directions, but it does not seem to have impressed itself upon the teaching, and, in fact, was not generally connected with the colleges. As is to be expected in a new country, it expended itself mainly in exploration, in geological, botanical and ornithological collection, and the school of wandering naturalists, connected, perhaps, chiefly with Philadelphia, would furnish an interesting chapter in the history of science.

What research there was in chemistry and physics, not yet differentiated, was largely in the hands of the medical profession, and here again the interest centers in the city of Philadelphia, partly on account of the presence in that city of the ingenious Robert Hare; partly because of the tendencies of the University and medical school; partly on account of the scientific traditions of the city, dating from the time of Franklin and his associates.

Many of the early contributors to 'Silliman's Journal' were physicians, with Robert Hare at their head, both in reputation and apparently in original ability. He made one addition of the first importance to the resources of the chemical investigator by his invention of the compound blowpipe, and in his two forms of voltaic cell, the 'deflagrator' and the 'calorimotor,' he foresaw dimly that fundamental law of the electric current now connected with the name of Ohm. Dr. Hare filled the chair of chemistry in the medical school of the University of Pennsylvania, and his lectures were brilliantly illustrated and of high repute.

In the history of the teaching of science, as distinguished from that of active research, the most prominent figure in the first half of the nineteenth century is not at Philadelphia, but New Haven, and its characteristics are not original power, but enthusiasm for teaching, administrative ability, social influence, sound and clear judgment.

Benjamin Silliman was graduated from Yale in 1796, with high honor and a reputation for sound scholarship. It does not appear that he had distinguished himself in scientific studies—the opportunities of specializing in that direction were not great at the Yale of that day—and he studied law after graduation from college, combining with his studies the work of a college tutor. He was admitted to the bar in 1802. In this year a chair of chemistry and geology was established in the College and offered to young Silliman, who, at the solicitation of President Dwight, forsook the law and accepted the position.

He spent two years in fitting himself for his work, going first to Princeton, where, it is said, he first saw experiments in chemistry performed; then, after a little, to Philadelphia, remaining there till 1804. In 1805 he was abroad for nearly a year, studying and collecting apparatus and specimens. Entering upon his work, he continued in charge of his department for fifty years. His acute insight soon perceived that a pressing need of the science of the country was an organ of intercommunication, and in 1818 he founded the *American Journal of Science*, better known for half a century as 'Silliman's Journal.' This venture involved at first considerable pecuniary sacrifice, but became self-supporting in about four years. Its influence was very wide. In 1822 Silliman writes: "Its most extensive patronage is derived from the city of Philadelphia, which takes more copies than any other community; the cities of New York and Boston afford it about an equal and a very respectable and an increasing patronage. It is well

sustained by Connecticut and most of the Eastern States; it is not without patronage beyond the Alleghenies, but the state of the currency has made it necessary to relinquish an extensive subscription in those regions. Washington, Baltimore, Charleston, and the Southern States generally, but especially South Carolina, demand a very considerable number of copies, and all the smaller cities receive a proportionate supply."

Already, then, the journal had assumed the representative character which it still holds, and the position of its editor among the leaders of American science was assured.

Besides his class-room and his journal, Silliman's public lectures on scientific subjects, delivered in many parts of the country, were of great value in arousing popular interest. These, like his class-room lectures, were eminently pleasing in manner and brilliantly illustrated. The courses delivered in Boston in 1840–43 first inspired the boy Josiah Cooke with an interest in chemistry which bore fruit years afterward in the sudden establishment of systematic teaching of that subject at Harvard. In his own college, of course, his influence was direct and powerful, and it was mainly his support and approval which made possible the movement toward practical chemistry at Yale. So preparations were made for the great movement of fifty years ago. At Yale the son of Professor Silliman was one of the chief actors.

Benjamin Silliman, the younger of the name, was graduated from Yale in 1837. The sailing of the Wilkes exploring expedition, carrying away James D. Dana as geologist, left vacant at once for him a place as his father's assistant, and in his father's laboratory he received the chemical training not yet available in the undergraduate courses. Impressed with the value of this practical experience, he began in 1842 to receive a few students into his laboratory, among them J. P. Norton, afterward his assistant and colleague. This personal and private instruction was the beginning of advanced chemistry at Yale. The 'Department of Philosophy and the Arts,' under the charge of the younger Silliman as professor of chemistry applied to the arts, and Mr. J. P. Norton, fresh from two years of study at Edinburgh and Utrecht, as professor of agricultural chemistry, took possession, in 1847, of the old President's House on the College green. They paid rental to the College for use of the building, and—such was the encouragement given in those days to the teaching of science—fitted it up at their own expense and served in it without salary. "The College, indeed," says Professor Lounsbury in his 'Historical Sketch of the Sheffield Scientific School, "the College, indeed, had no money to give, but, even if it had, it is more than doubtful whether it would have given it. No one at that time, however enthusiastic, ever dreamed of the supreme importance which the natural sciences soon were to assume in every well-devised system of education. The impression, indeed, seemed to prevail that chemistry, like virtue, must be its own reward."

The School, from an educational standpoint, was successful from the beginning. Norton's lamented death, in 1852, opened a place for J. A. Porter, a pupil of Liebig, who had just resigned a similar position in Brown University. Professor Porter was a son-in-law of Joseph E. Sheffield, and to this connection was due in a great measure the expansion of these beginnings into the Sheffield Scientific School.

At Harvard, at about the same time, two streams of influence converged to swell the interest in science teaching. E. N. Horsford was called to fill the 'Rumford Professorship of the Application of Science to the Useful Arts,' in Harvard University. Horsford was a graduate of the Rensselaer Polytechnic Institute, the earliest school in

the country to make a point of laboratory teaching. After seven years spent in teaching, surveying and geological work, under James Hall, he went abroad to study, becoming a favorite pupil of Liebig, and brought to Cambridge the methods and ideas of the Giessen laboratory.

He immediately formulated a scheme for the teaching of practical chemistry, and presented plans for a laboratory. These papers were laid by the Treasurer of the College before Abbott Lawrence, who supplied the necessary funds for this enterprise and for two other departments of geology and engineering. Agassiz was called to the chair in geology. The chemical laboratory was built in 1849, and Professor Horsford administered its affairs for sixteen years with vigor and success.

The tragedy connected with the name of Professor Webster left a vacancy in chemistry at Harvard, and in 1850 J. P. Cooke, then only twenty-three years of age, was elected to the Erving professorship of chemistry and mineralogy. The strongest opposing candidate for this position was David A Wells, the first graduate in chemistry from the Lawrence Scientific School, since distinguished for his writings on economic subjects.

Cooke was in chemistry self-taught, with little experience as a teacher, but full of an inextinguishable enthusiasm, and an immense capacity for work. He was attracted at once to Liebig's methods, introduced by Horsford three years before. With the usual encouragement then given by college authorities in these subjects, he was permitted for the most part to provide his own apparatus and pay his own expenses, and not for seven years was his laboratory course admitted into the regular college curriculum. Even after this formal recognition a large part of the expenses of the chemical department was defrayed by Professor Cooke, and his private collection of scientific apparatus became famous and of great service to others besides himself. As lately as August, 1871, Professor Trowbridge, in describing his new cosine galvanometer, says: "My thanks are due to Professor Cooke, of Harvard College, for the generous use of his apparatus for electrical measurements;" showing that even at that date the physical department of the College possessed no adequate collection of such instruments, but that the professors were still compelled to depend largely upon private resources.

A similar development began in 1850 at the University of Pennsylvania under James C. Booth, afterward developing into the Towne Scientific School, and at a little later date at the University of Virginia under J. Lawrence Smith. At Dartmouth College the Chandler Scientific school was founded in 1851.

At Brown University a heroic effort was made by President Wayland to enlarge the curriculum, introducing elective studies and increasing the possibility of scientific training. His notable report to the trustees, in 1850, was in advance of the age, and although an effort was made to carry out his suggestions, and chairs were established in practical chemistry and engineering, the movement gradually waned from lack of interest and support. A scientific school was established at the University of Michigan in 1852, and a chemical laboratory built in 1856. Few other colleges appear to have felt the rising scientific wave until later.

All these scientific departments centered at first around the chemical laboratory. This is only natural, as in that science the laboratory method of teaching was first systematically developed.

The great center of practical teaching, which revolutionized the methods of the world, was Liebig's laboratory, founded at Giessen soon after his establishment there as professor, in 1826. The direct influence

of this famous school upon Porter and Horsford has been already noted; the indirect influence, in all directions, must have been far greater.

Physical laboratories were yet unknown for some years, probably because the separation between chemistry and physics had not yet definitely taken place. The treatment of heat and electricity in the older text-books of chemistry, as agents of chemical change, tended to hold the two departments together, and in some large institutions, as, for example, the University of Michigan, these important portions of physics were, for nearly forty years after the period we are discussing, under the control of the department of chemistry.

As laboratory teaching in chemistry is connected with Liebig, so systematic laboratory work in physics is associated with the name of Kohlrausch, whose *Leitfaden*, still a standard work of reference, was the first practical text-book on that subject.

Professor W. B. Rogers appears to have made the suggestion which led to the establishment of the earliest physical laboratory in this country at the Massachusetts Institute of Technology, and Professor Pickering's Physical Manipulation opened the way for the ever-increasing host of laboratory manuals in physics.

It will be seen from the above sketch that the great incentive to the founding of scientific schools in this country was the growing appreciation of the value of applied chemistry in arts and manufactures.

Of general interest in pure science, at least chemical and physical, there was little or none; but the recognition of the value of applied science led, within a few years, to the great company of technical and engineering schools which have been, until very lately, the most imposing feature in our American system of higher education.

First among these, by many years, was the Rensselaer Polytechnic Institute, of Troy, New York, the early history of which merits some attention. It was founded in 1824, by Stephen Van Rensselaer, and practically placed under the charge of his protégé, Amos Eaton. The purpose of the school was defined by the founder to be the instruction of 'persons who may choose to apply themselves in the applications of science to the common purposes of life.' "My principal object," he adds, "is to qualify teachers for instructing the sons and daughters of farmers and mechanics, by lectures or otherwise, in the applications of experimental chemistry, philosophy and natural history to agriculture, domestic economy, the arts and manufactures."

Professor Eaton gave to this philanthropic idea a turn of great originality and value. Since he was to educate chiefly lecturers, they should learn to lecture at the school. Since they were to lecture on the applications of science, they should themselves become practical manipulators. The work, therefore, of the classes consisted largely "of experiments in chemistry, performed by themselves, and in giving explanations, or the rationale of the experiments * * *; the students thus themselves acting as lecturers, and the professors as students." Laboratory methods, in fact, were used throughout, and the school was equipped, so far as possible, with this idea in view. Doubtless the work was not so well systematized as in Liebig's laboratory, opened several years later, but it was an original and independent movement in the same direction, and that it was efficient may be inferred from the number of well-known men of science who were graduates of this school. Slowly, in response to popular demand, the Rensselaer Institute turned more and more toward engineering, and it is a curious fact that the very epoch which beheld other institutions broadening their scientific courses saw this one, in the reorganization of 1849–50, contracting its field

practically to that of a school for civil engineers.

Of the great number of technical schools which have sprung up since 1850 there is no need to speak. But the interest in science has gradually passed far beyond the mere interest in its applications.

The striking features of the last twenty years have been the spread of science teaching by laboratory methods in the secondary schools, and the growth of university instruction in science, as distinguished from technical. The noble gift of Johns Hopkins, and its wise administration, began the latter movement, which resulted in the establishment of graduate schools all over the country. The State universities, with their large resources, were, in some parts of the land, great aids in this work, though in others they kept more closely in touch with the technical side, as is very natural with institutions supported by the public at large.

The growing fashion among students, of completing their years of study in Germany, has had a most important effect. The instructors in science in our colleges are drawn more and more from those who have added German training to that of their native country, and as a result the ideals in these institutions are approximating to the German ideals.

Ability in the direction of original research is in some places the first quality looked for in a student or required of an instructor, and the modern tendencies toward extreme specialization and hasty publication are natural results.

So far the movement has undoubtedly been productive of good to the whole educational system of this country. There has been an arousing, an awakening, in educational ideas and methods, not in science only, but in all other subjects, that is little less than marvellous to him who can look back five and twenty years. Whether, after our American fashion, the pendulum may swing too far, and the movement bring with it the difficulties which always attend exaggerations, it is too early yet to say, but, so far as we have gone at present, not only teachers of science, but all teachers, may join, in spirit at least, with the meeting at Boston, which really celebrates the beginnings, not merely of a scientific association, but of a great scientific and educational movement, of which the Association forms but a part.

Frank P. Whitman.

HYDRAULIC ILLUSTRATION OF THE WHEATESTONE BRIDGE.

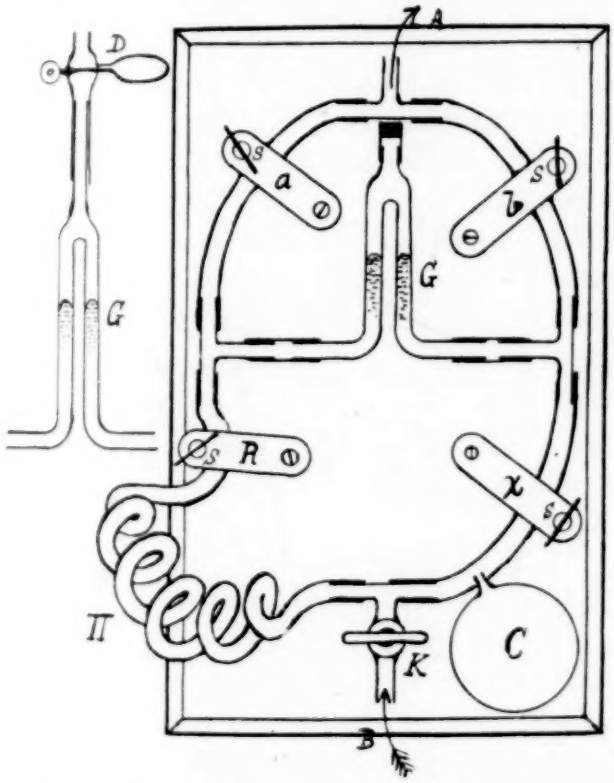
Although it is undesirable to push the analogy between the electric current and the flow of water too far, or to get the idea of an actual current too firmly established in the student's mind, still a hydraulic illustration is often useful to point out how the results may follow.

To show the action of the Wheatestone bridge by flowing water is usually complicated by the effects of gravity, and illustrates the conditions of pressure rather than those of resistance to flow. Moreover, the question of the galvanometer is a troublesome one, inasmuch as most devices require such a flow of water as to interfere with the bridge effects which it is desired to bring out.

The arrangement described below has proved quite satisfactory in showing the simpler resistance effects in the bridge, but especially useful in making clear the effects of capacity and self-induction, and how the two may be balanced and compared.

The accompanying sketch is taken from a simple home-made bridge which was constructed as an experiment. Upon a board about $30 \times 50 \times 4$ cm. are fastened four glass T's of about 5 mm. inside diameter. Two of these T's have their side projections

turned inward and are connected, by short pieces of rubber tubing, to the 'galvanometer' G. The other two T's have their side projections turned outward, and these connect by long pieces of tubing with two large aspirator bottles, not shown; a, b, R and x are brass strips held under a screw at the inside end and resting over rubber tubes which can be compressed and closed by the screws *ssss*. These screws are made by soldering a piece of brass about $15 \times 25 \times 1$ mm., with corners rounded, into the slot of a common wood screw. Under R is a piece of tubing several



feet long when self-induction is to be shown; otherwise a short piece is used, like those under a, b and x, just long, enough to connect the corresponding T's. C is a pint aspirator bottle, with its small side tubulure inserted into the side of the rubber tube. The 'galvanometer' is a T of peculiar form, as shown, closed at its top by a rubber tube and plug or pinch cock, as shown at D. It is really an electrometer, as it shows difference of pressure (potential) instead of current. In operation the board lies horizontal on a table and the tube G is stood up perpendicular so that it becomes a manometer. To start the appartus fill the large bottle connected with B and set it higher than the board, tilt the A end of the board up ten or fifteen degrees, place the A bottle lower than the B one and open the stop cock (key) K. The water will flow through the tubes, driving out the air, and a little manipulation of D will bring the water in the manometer to a convenient point. The board is then to be placed horizontal again. By compressing a and b about equally resistance to flow is introduced into these two arms of the bridge; then compressing x will require a corresponding compression of R in order to balance the pressure in G. It will be readily seen that the qualitative effects can be thus shown, but for quantitative relations it would be necessary to replace the crude compressors by graduated stop cocks. The capacity can be regulated by closing K, raising the A bottle and taking the cork out of C, allowing it to fill more or less and then replacing the cork; the 'capacity' is proportional to the air left in C. When C is full there is no capacity in x. Self-induction is proportional to the length and curvature of the long tube, Π, under R. Self-induction and capacity are shown by a momentary difference in level in the manometer upon opening and closing K, the throw (balistic galvanometer) being in the opposite direction on closing K to that upon opening K. Changing the levels of the A and B bottles will show that the results are independent of the direction or value of the pressure (electro-motive force). The manometer (galvanometer) may be made more and more delicate by turning it down more and more nearly horizonal, and by projecting the image of G upon a screen its operation may be shown to a large class.

Individual ingenuity will devise many variations and improvements in details and experiments; the fancied merits of the ap-

paratus lie in the galvanometer device and in the elimination of the effects of gravity pressure in the bridge itself, as well perhaps as in the self-induction and capacity elements.

William Hallock.

Fayerweather Hall,
Columbia University,
July, 1898.

THE ECHELON SPECTROSCOPE.

The invention of the Echelon spectroscope is the most important advance in optical research which has been made in many years. It has always been the ambition of the physicist to spread the spectrum with which he was working out to the greatest possible length to see if perchance the changes in color are continuous or not. Thus it happened that a single prism gave way to trains of prisms, each member of the train doing its share to wrest asunder the inconceivably minute vibrations which were the objects of study. With this same end in view prisms gave way to diffraction gratings, these latter giving purer and more diffused spectra. Great labor and skill have been expended in improving these gratings until now their perfection has been pushed to well-nigh the limit of human possibility by the masterful work of Professor H. A. Rowland.

It, therefore, becomes evident that if this resolution of the spectrum is to be carried notably further some entirely new means of attaining the end sought must be adopted.

The important discovery by Zeeman last year that the magnetic field alters the nature of the vibrations of light roused physicists generally to a new effort to render visible these changes which are very small, their details lying beyond the reach of the best of Professor Rowland's gratings.

The result of these efforts is the Echelon spectroscope, an instrument beautiful in its simplicity, yet powerful beyond anything ever seen before. To its inventor, Professor A. A. Michelson, belongs the credit of opening the door to a new and hitherto unattainable field of spectroscopic observation, a field which promises to yield much valuable information to mankind regarding the interaction between the infinitely small particles of matter and those unseen forces, electricity and magnetism.

What, then, is the principle of this new instrument? The theory of diffraction gratings tells us that their dispersive power depends on two things: First, on the distance between two consecutive openings; and, second, on the order of the spectrum. The dispersion is greater the smaller the distance between the openings and the higher the order of the spectrum. The efforts of physicists have hitherto been directed towards making the distance between the openings of a grating as small as possible as a means of spreading the spectrum out as far as possible. No attempt has, so far as I know, been made before this to produce spectra of higher order than the fourth.

This is the point of the new instrument. It is capable of giving spectra of almost any order, the limit depending on the accuracy with which the plates composing it can be prepared. In the actual trial instrument made in this laboratory the order of the spectrum given is in the neighborhood of 20,000.

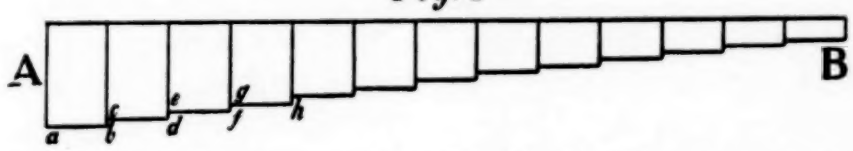
For the mathematical theory of the instrument the reader is referred to Professor Michelson's two articles on the subject.*

One can gain a practical idea of its way of working as follows: A diffraction grating consists essentially, as is well known, of a series of equidistant openings. The spectrum of the first order is formed when the light, in going from its source to the

* *American Journal of Science*, March, 1898; *Astrophysical Journal*, June, 1898.

point of observation through one opening in the grating has travelled exactly one wave more than it has in passing from source to point of observation through the next adjacent opening. The spectrum of the second order is that spectrum which is formed when this difference of path amounts to exactly two waves, etc. Thus when one is observing the spectrum of the second order, say, he has matters so arranged that the light from the source is divided into numerous thin beans, each of these beams having to travel two waves farther to reach its goal than its adjacent beam on one side of it, and two waves less than its adjacent beam on the other side of it. If, then, one wishes to obtain spectra of the order 20,000, say, he must arrange the conditions of the experiment so that this difference in the optical path for various sections of the light shall be 20,000 waves instead of two. This result is accomplished in the Echelon spectroscope by building up a flight of steps of optical glass of a given thickness. The diagram (Fig. 1) shows a plan of this arrangement.

Fig. I



The blocks of glass composing this 'staircase' must be of exactly the same thickness, a result which is accomplished by polishing a plate of optical glass until its opposite surfaces are plane and parallel to each other, and then sawing this plate into pieces of the requisite size.

Suppose now a beam of parallel light to fall on this pile of plates perpendicular to the face at *A*. In passing through the first block from *a* to *b* the beam will be retarded by, say, 20,000 waves, the number depending on the thickness and the index of refraction of the glass. Part of the light then comes out into air through the narrow opening *bc* and the rest goes on through the block *cd*. The part of the incident beam which comes out through the opening *de* has also been retarded 20,000 waves over the part that came through *bc* and so on. It is thus easily seen that this instrument, when looked through along the axis from *B* to *A*, gives the required conditions for the production of a diffraction spectrum of high order; for we have the light between the source and the point of observation divided into a number of beams, each of these beams having to travel 20,000 waves farther to reach its goal than its adjacent beam on one side of it, and 20,000 waves less than its adjacent beam on the other side of it.

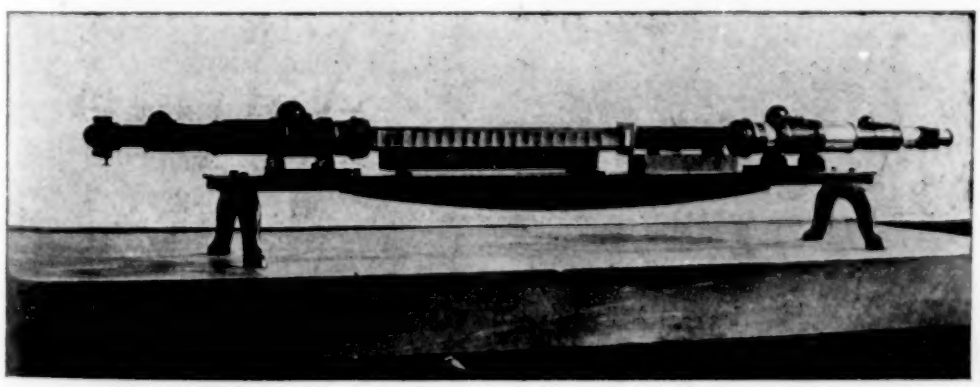


FIG. 2.

The cut (Fig. 2) represents a spectro-

scope built on this plan now in use in this laboratory. Its 'Echelon' consists of twenty plates each 18 mm. thick. Each plate projects 1 mm. beyond the next succeeding plate. It has a resolving power of about 300,000. A larger Echelon with thicker plates is being built here now which will have a still larger resolving power.

It is hard to say when the practical limit of resolving power by this instrument will be reached. But it is quite certain that 500,000 is soon to be attained. When we consider that the best gratings have a resolving power of only 100,000 we see how great an advance has already been made. Zeeman discovered that in the magnetic field the spectral lines were separated into three components, but with the Echelon spectroscope now in use here it is possible to see the doubling and tripling of these components which was discovered by Professor Michelson* by means of visibility curves.

The disadvantage of the instrument is that it will not give a continuous spectrum, but its advantages in cheapness and enormous dispersion for small portions of the spectrum make it an invaluable addition to the means at hand for analyzing vibrations of light.

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University of Chicago.

THE RELATION OF SCIENCE EDUCATION IN THE SECONDARY SCHOOLS TO THAT IN THE COLLEGE AND THE UNIVERSITY.†

In discussing the nature and the scope of the science work in the secondary schools one principle, I think, is recognized by all as being fundamental, and this is that the training of specialists is not the function of the high school. Neither is it a part of the college in any but a limited sense, while, on the other hand, it most emphatically does come within the sphere of the university.

In laying down this principle, I am well aware that by far the greater number of high school pupils never intend to continue their education in any other institution of learning, and that their future advance must be made without the aid of professional teachers. To my mind, this makes no difference. There are certain broad foundations which, if the course is to be of lasting benefit, must be laid alike for all.

The development of the pupil's reasoning power and his faculties of observation are the important objects to be attained, and not to fill his mind with masses of facts and figures, which are as surely forgotten as they are learned. Such accumulations are defended only on the ground that they are of so-called 'practical benefit;' in reality, they constitute the most unpractical portion of any school course. Such things belong to the training of specialists, and consequently to the university, and even though the specialist can obtain a great number of necessary data from books and tables, after he has completed his studies he never can acquire the necessary fundamental training in the use of reason and logic, if he has neglected these essentials in the beginning. That which I have said applies to all branches of study—to the languages, to history or to mathematics as well as to the natural sciences; for all of them the same broad pedagogical principles are necessary.

I have used the term 'specialist' in its broadest sense in referring to high school students. It is in my opinion as grave a mistake to develop the pupil's training mainly along the scientific line as it is to confine him to humanistic studies alone. It is just as essential that the student in biology, physics or chemistry should be

* *Philosophical Magazine*, April, 1898.

† Address of the President of the Natural Science Department of the National Educational Association, July, 1898.

well grounded in the languages, history and mathematics as it is for the other class to have a knowledge of the methods of scientific thought. In other words, I would have every high school pupil take work of both kinds, and I greatly deprecate the tendency to divide the secondary school curriculum into 'classical,' 'scientific' and 'English' from so-called 'practical' motives, for, as I have already said, these motives seem to me in reality the most unpractical. Some differentiation, no doubt, may be allowed, but none should be tolerated that will in any way be detrimental to a well balanced growth of the pupil's mind. The high schools will do good only in so far as they develop reasoning, thinking and normal citizens.

Coming to that topic which more nearly concerns us, the teaching of the sciences, it goes without saying that a smattering of a number of sciences is of no value whatever. No high school pupil can hope to become a scientist in the limited time during which he studies, nor even if time allowed is his mind sufficiently matured to enable him to have the proper point of view. As a consequence, it is of very little importance, with certain reservations, what sciences he studies, so long as he learns something of the methods of reasoning and the habits of thought which apply alike to all. Of course, it must always be borne in mind that certain sciences are fundamental to others, a considerable mathematical knowledge being necessary for physics, and undoubtedly a certain familiarity with physics is requisite before beginning the study of chemistry. Such subjects cannot be placed out of their regular order without doing violence to all; they must be kept so if the object aimed at, familiarity with the methods of scientific reasoning, is to be attained.

No one can hope to become conversant with all of the fundamental principles in any one science in any one year, or even in many years, and that this is so is evident when we pause to consider the number of lives which during the last two or three centuries have been devoted exclusively to the task of bringing our methods in the sciences up to their present standpoint. Take the atomic theory alone. How many years of toil, how many hard-fought battles, how many great names, have during the past century been devoted to its perfection! Dalton, Berzelius, Guy-Lussac, Wöhler, Dumas, Stas, Avogadro, Cannizzaro, Clausius, Clerk-Maxwell, Thomson, Mendeléef and hosts of others have given their best years to it—and what it has taken such minds to develop we expect the high school student to grasp in a day! The same with all of the great theories of modern science; all represent the present convergence of many and often diverse views, held by numerous men who honestly fought and toiled in their chosen fields and whose names will live for all time. Shall subjects which represent so large a share of human thought be treated lightly as mere collections of shibboleths and signs, as mere accumulations of data, just as we remember how many pounds there are in a ton, or how many inches in a foot? Shall we value them simply for the applications which they may have in the obtaining of food and drink, and in the manufacture of clothing and machinery? Indeed, can we make any so-called 'practical applications' of them without comprehending the main theories on which they are based, and of which the application is only an offshoot?

All valuable theories in science must be, and are, founded on facts and facts only; their adoption has often been the result of the accumulation of a multitude of these, but their comprehension may be brought about by a careful selection of any one series, the members of which are so logically connected in the pupil's mind that the

theory must follow as a result of their existence.

The high school, then, should teach the student to reason in any science it undertakes to teach; it should give time enough to it so as to accomplish this end; it should carefully and conscientiously select those facts only which are of fundamental importance in developing the great theories, and it should so connect these facts that the great theories follow as a logical result. By so doing it will develop a thinking human being who can use what he has learned in any emergency, and who has in him the seed of further development. All other methods are false to science, misleading to the pupil, acting as soporifics instead of stimulants. On this line there can be no compromise.

All scientific work should be experimental. We have advanced to the point where this is universally recognized. It is, however, too frequently the custom to introduce experiments solely because they are cheap. This is a grave mistake. The main question should be: Do they teach what is necessary and are they not too complex for beginners? It is folly to attempt the study of a science with a lot of cheap and misleading experimental claptrap. If fundamental experiments can be performed cheaply, so much the better, but if the science is to be properly taught they must be undertaken whether cheap or dear, or if financial considerations render this impossible the science itself should be abandoned in favor of something else. It is the same principle on which some people go shopping—they buy many things that they do not want, simply because they are cheap, and they go without the necessities because they are dear; yet if they would only refrain from the first line of action they might ultimately save enough for the second.

The high school course is preparatory to that of the college, but it can never take the place of the latter. No student, however well prepared, can, in broadening his learning, afford to do without the fundamental work given by men who have, by their own researches, advanced their sciences. Only such men can truly generalize; only such men are able so to paint the scientific picture that the great truths stand out prominently against a background of minor facts and theories; only such men can produce an harmonious whole. It is in the very nature of things that the place of these advanced workers cannot be taken by the high school teachers. They have neither the time nor the opportunity, excepting in rare instances, to take any prominent part in the progress of their especial lines of work. For this reason the secondary school teacher should draw his inspiration from the investigators; he should follow them as leaders, and, in looking for such guidance, should first ask: 'What have they done?' not: 'With what institution are they connected?' It is a fallacy too often heard that the secondary school teacher alone can write for the secondary schools, because 'he understands the needs of the pupils.' True, he may understand how to write a book which will teach easily, but does he understand what are the fundamental principles of his subject? Does he not perhaps delineate what he *thinks* are the fundamental principles, without knowing that they may be either past history, or, worse still, entirely fallacious?

Too often the college teacher is compelled to entirely undo that which the pupil has learned in the high school—to clear the latter's mind of mistaken notions and to completely reconstruct his mental perspective—before the new work can be undertaken with mutual profit. Those who have gone through this trying ordeal realize that it is a far greater task to eliminate false impressions than it is to create new and right ones.

The high school teacher should develop the power of reasoning and exact observation; the college teacher the power of generalizing and the creative faculty; he should strive to teach the student to think in the terms of his science. To do this he must himself be a creator; he himself must have engaged in lines of original thought and investigation; he must be a living spring, not a pail of water. I have heard it said that the best teachers are often those who have never been able to engage in original research. I am inclined to doubt this. Granted, the investigator may not have the power of fluent speech in the same degree as some others, but he has the inspiration; he has the 'point of view;' he is able to feel relationships and connections which the other cannot, and as a consequence is able to place his pupil's learning on a broader and more permanent basis.

Finally, the college is not the place for narrow specialization; in it the scientific student should still be laying his broad foundation, with the understanding that he must also be gaining a clearer view of the sister sciences which are related to and necessary for an understanding of that which he has chosen for his main subject. The college is no more than the high school the place for technical training, for the latter is never developed in its proper form unless its foundations are laid broad and deep, so that they will, without strain, support any superstructure which may be be placed upon them. It is only when this is the case that the uuiversity development can have its proper meaning. The college should bring forth the man *prepared* to specialize, not the man who has, by a too early following of a narrow line, stunted his power of future development. The university should be able to take many things for granted; it should at once be able to devote its time to the growth of the professional biologist, physicist, chemist, mineralogist or geologist; and, while, of course, it cannot lose sight of the fact that at no stage of the scientific career are the related sciences to be neglected, it should, nevertheless, be able to count on training proper and sufficient to fit the student for the original thought and work which must become a part of his being; for, if he wishes to accomplish anything, these habits must be with him through life.

In this way the scientific training of a student becomes a harmonious whole without break, let or hindrance, from the beginning in the secondary school up to the mature work of the investigator and teacher; for the members are of one race and of one people, forever whole and indivisible.

PAUL C. FREER.

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THE LACOE COLLECTION IN THE NATIONAL MUSEUM.

IN SCIENCE for July 3, 1896, the late Dr. G. Brown Goode announced the very valuable gift of the 'Lacoe Collection of Fossil Plants.' At that time Mr. R. D. Lacoe, a leading business man of Pittston, Pennsylvania, presented to the U. S. National Museum by far the largest and most valuable collection of Paleozoic plants in America, comparing favorably with the richest collections of the same nature in European museums. Living in a region rich in fossil plants, and noting early in the seventies that no great collections of this kind were accumulating, and also that little or no attention was being given to securing American Paleozoic insects, which are among the rarest of fossils, he quietly set to work gathering material and assisting paleontologists in the study of his collections. The plant collection contains nearly 100,000 specimens and is stored in 1,000 museum drawers and many large exhibition cases. There

are about 750 types and illustrated specimens in the collection.

Recently Mr. Lacoe has presented the balance of his splendid collections, consisting chiefly of fossil insects. The liberality of the gift is as unfettered with conditions as its value is great. The collection is to be known as the 'Lacoe Collection,' and the only stipulation is "that it be accessible to scientists and students without distinction, provision being made for the proper preservation of the specimens from loss or injury."

Of the 182 described species of North American Paleozoic insects about two-thirds are represented in the 'Lacoe Collection' by the type specimens, besides many figured supplementary types. Of arachnids there are 62 specimens (14 types), myriapods 94 specimens (41 types), and insects 461 specimens, of which 116 species are described (136 types); about 300 specimens are unstudied. There is but one other Paleozoic collection equalling or exceeding in specimens the Lacoe Collection, namely, that from the coal fields of Commentry, France.

Of Tertiary insects from Florissant, Colorado, several hundred unstudied specimens and six described species are present, including a butterfly, one of the rarest of fossil insects. From the Tertiary of Oeningen, in Baden, there are about 3,500 specimens, of which about one-half (including about 428 species) have been studied by Mr. Samuel H. Scudder. Regarding this part of the Lacoe Collection Mr. Scudder writes (Geol. Mag. Dec. IV., Vol. II., 1895, pp. 116–122): "I have examined with some care his large collection of fossil insects from Oeningen, larger, perhaps, than any outside of Zurich, for it consists of about 3,500 specimens, of which fully one-half may be made use of to advantage.

"The 428 species which I have separated in Mr. Lacoe's collection are divided among the orders as follows: Orthoptera 8, Neuroptera 13, Hemiptera 57, Coleoptera 294, Diptera 17, Hymenoptera 39." From the Mesozoic and Cenozoic of Great Britain there are about 250 specimens.

Of Crustacea there are about 170 specimens, of which 11 are types or figured specimens. Of fishes and reptiles there are some 300 specimens, about half of which were labeled or described by the late Professor Cope.

Mr. Lacoe intends to continue his interest in the increase and study of 'The Lacoe Collection.' With the numerous Tertiary insects from the Western States gathered by the United States Geological Survey and studied or to be studied by Mr. Scudder, the United States National Museum will have one of the most comprehensive collections of fossil insects extant.

Dr. Goode's appreciative words regarding the plant collection are also applicable to the insect collection: "The acquisition of this wealth of material makes the National Museum an important reference center for all future comprehensive work in this field. The Lacoe Collection is a noble monument to the public spirit and generous enthusiasm of its founder."

A NEW NAME FOR THE GEORGIA OLD FIELD MOUSE.

In my 'Land Mammals of Peninsular Florida and the Coast Region of Georgia,' (Proc. Boston Soc. of Nat. Hist., Vol. 28, No. 7, pp. 202–203, March, 1898), I described under the name '*Peromyscus subgriseus arenarius*,' the dark-colored form of the old field mouse found by Mr. W. W. Brown, Jr., on the sand hills about Hursman's Lake (Savannah River), near Bascom, Scriven Co., Georgia. After my manuscript had been turned in I noticed that I had used a name already given to a *Peromyscus* by Dr. E. A. Mearns. (The *Peromyscus eremicus eremicus* Mearns, Proc. U. S.

Nat. Mus. Washington, p. 138, 1896.) I meant to correct my mistake when I read my proof, but I neglected so to do.

It, therefore, becomes necessary to give the Georgia old field mouse a new name and I propose for it *Peromyscus subgriseus baliolus** nom. nov. *Type*, No. 5925, Coll. of E. A. and O. Bangs, described under above reference as *Peromyscus subgriseus arenarius*.

OUTRAM BANGS.

BOTANICAL NOTES.

SEEDS AND VERY LOW TEMPERATURES.

Two English investigators, H. T. Brown and F. Escombe, recently made some interesting experiments upon the ability of seeds to endure very low temperatures. In the Jodrell laboratory, of the Kew Gardens, they enclosed seeds in thin glass tubes immersed in a vacuum-jacketed flask containing about two liters of liquid air; the latter was replenished so as to submit the seeds, for one hundred and ten hours, to a temperature of from −183° C. to −192° C. (−297° Fahr. to −313° Fahr.). The seeds used were: *Hordeum distichon*, *Avena sativa*, *Cucurbita pepo*, *Cyclanthera explodens*, *Lotus tetragonolobus*, *Pisum elatius*, *Trigonella foenum-graecum*, *Impatiens balsamina*, *Helianthus annuus*, *Heracleum villosum*, *Convolvulus tricolor* and *Funkia sieboldiana*. They had previously been air-dried, and contained, when the experiment was begun, from ten to twelve per cent. of moisture. After their prolonged exposure to the intense cold indicated above, they were slowly thawed, the process requiring about fifty hours. They were then tested as to their germinative power, by comparison with seeds from the same lots, which had not been subjected to this low temperature, with the result that 'their germinative power showed no appreciable difference from that of the controls, and the resulting plants, which were in most cases grown to full maturity, were equally healthy in both cases.'

This astonishing result can not fail to attract much attention, not only of botanists, but of gardeners and farmers as well. That this was not due to unusual or accidental conditions is shown by experiments by other investigators, cited by Messrs Brown and Escombe. Thus DeCandolle and Pictet in 1884 exposed seeds for four days to a temperature of −100° C. (−148° Fahr.) without destroying their vitality, and in 1895 the former exposed seeds in the 'snow box' of a refrigerating machine for a period of one hundred and eighteen days to a temperature of from −37° C. to −53° C. (−34.6° Fahr. to −63.4° Fahr.), a treatment which most of the seed are said to have 'resisted successfully.'

While these experiments are very interesting as showing that mere lowering of temperature may not necessarily destroy the vitality of seeds, it is fair to the investigators to say that this was not their principal object. They aimed to determine the condition of the protoplasts of the resting seed, whether (1) 'the essential elements of the cell, during the period of inertness, are still undergoing feeble but imperceptible alteration, accompanied by gaseous interchange with the surrounding atmosphere,' or (2) 'that all metabolism is completely arrested in protoplasm when in the dormant state, and that it then loses, for the time being, all power of internal adjustment to external conditions.'

In other words, they asked the question: 'Is the machinery of the dormant cell merely *slowed down* to an indefinite extent, or is it completely *brought to rest* for a time, to be once more set going when external conditions are favorable?' To this question they make answer that 'we must regard the protoplasm in resting seeds as existing in an absolutely inert state, devoid of any trace of metabolic activity, and yet conserving the potentiality of life.'

* Baliolus=dark-brown, swarthy.

THE SCIENTIFIC WORK IN THE DEPARTMENT OF AGRICULTURE.

It is not many years since the scientific men of this country were entirely indifferent to the work of the United States Department of Agriculture. They were indifferent because the work of the Department was so poorly done that trained men knew that it was practically valueless; now and then one still finds a remnant of this old feeling in elderly men who have not kept in touch with the development of the Department during the past few years. That this prejudice has no longer any foundation in fact (if we except the free-seed-distribution folly) may be seen by an examination of the recently published 'Historical Sketch of the United States Department of Agriculture,' compiled by Charles H. Greathouse, of the Division of Publications. From it we learn that there are a full dozen 'divisions,' 'bureaus' and 'offices,' which are concerned with scientific problems. Botanists are interested especially in the Division of Botany, established in 1869; Division of Forestry, established in 1881; Division of Vegetable Physiology and Pathology, established in 1886; Office of Fiber Investigations, established in 1890; Division of Soils, established in 1894; and Division of Agrostology, established in 1895. For these divisions there are annually appropriated for expenses, from $80,000 to $100,000, in addition to separate appropriations for salaries, library and museum. If we add the Divisions of Chemistry, Entomology and Biological Survey, the aggregate of the appropriations reaches about $150,000. Every one of these divisions is in charge of well trained scientific men, who have surrounded themselves with expert assistants selected with great care and with especial reference to their preparation for the work to which they are assigned. No mention need be made here of the Weather Bureau, or of the Bureau of Animal Industry, with whose work the people at large are quite generally and favorably acquainted.

The publications from these scientific divisions reflect great credit upon the management of the Department. This is notably true of the divisions pertaining to botany, from which we have had many valuable scientific papers.

BOTANICAL PAPERS IN THE NEBRASKA ACADEMY OF SCIENCES.

The botanical papers printed in the recently issued 'Publications of the Nebraska Academy of Sciences, VI.,' are as follows: 'The Nomenclature of the Nebraska Forest Trees,' by Charles E. Bessey (giving the now generally accepted names of the sixty-seven species of native trees, and discussing their synonymy); 'A Comparison of Fossil Diatoms from Nebraska with Similar Deposits at St. Joseph, Mo., and at Denver, Colo.,' by C. J. Elmore (showing that these must have grown in fresh-water ponds or lakes); 'An Observation on Annual Rings,' by F. W. Card (showing that, contrary to popular belief, the growth of a second ring of wood in tree trunks does not occur as a result of defoliation); 'On the Internal Temperature of Tree-Trunks,' by R. A. Emerson (giving the results of a prolonged study of the problem, and showing that the temperature is greatly affected by the amount of water present); 'Data as to Wind-Distribution of Seeds,' by Edward M. Hussong (giving the results of observations by means of collecting trips, showing that while 'high winds' are effective agents in the distribution of heavy and rounded seeds they are by no means efficient in the dispersion of the comose, pappose and membranaceous seeds, these being carried much more efficiently by the lighter 'breezes' and 'local winds'); 'Chalcedony-Lime Nuts from the Bad Lands,' by Erwin H. Barbour (describing and figuring fossil embryos of seeds ob-

tained from the Miocene formation of the Bad Lands of the Hat Creek Basin, in northwest Nebraska; for these the name *Archihicoria siouxensis* is proposed, the embryo showing unmistakably their close relationship to the modern *Hicoria*.

THE OVARY OF OPUNTIA.

DR. JOSÉ RAMÍREZ, in the Anales del Instituto Médico Nacional, of Mexico, describes and figures three monstrous ovaries of *Opuntia*, which he regards as evidence of the axial nature of the inferior ovary in general. In the first case the ovary, though entirely normal in color, function, etc., instead of being articulated with the joint, is fused with it. Moreover, the spiral disposition of the arolae is continuous from joint to ovary. In the second example the ovary resembles a joint externally, while within it is in no wise different from a normal ovary. In the third a mature ovary bears thirteen perfectly developed ovaries, which are arranged spirally upon it. From the fact that the uppermost are already mature, the author concludes that the inflorescence of *Opuntia* is determinate.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

CURRENT NOTES ON ANTHROPOLOGY.

ON PYGMY RACES.

MR. R. G. HALIBURTON has devoted much time to the study of the pygmy races of men, and it is to his researches that the learned world owes the best information about the small people of the Atlas and Pyrenees Mountains.

Under the title 'How a Pygmy Race was found in North Africa and Spain' (Toronto, 1897, pages 147), he has republished the scattered articles containing his results, and added, also, various papers on other anthropological topics. Among the latter, as touching upon points of special interest, I may note one on 'The Days of Rest of Prehistoric Men,' which refers to the inauspicious, intercalary days of primitive calendars; and one on 'The Connection of November Flood-Traditions with the Pleiades,' where he ingeniously suggests that the sacredness of the number four in many mythologies may be due to the fact that the heliacal rising of the Pleiades corresponds to that of the new moon once in four years. Five articles refer to the Gypsies in Africa, and several to the customs and myths of ancient Egypt.

UNSOLVED PROBLEMS OF ANTHROPOLOGY.

MR. E. W. BRABROOK, in his third inaugural address as President of the Anthropological Institute of Great Britain, reviewed the recent progress of the science of man, and recounted the unsolved problems which it offers. It is worth while to quote these, as to know where we are especially deficient is the best preparation for extension of knowledge.

He mentions: (1) the development from the brute to man; (2) the *hiatus* between the palæolithic and neolithic periods in Europe; (3) the process of the disappearance of races; (4) the development of religions; (5) the accurate measurement of different races; (6) the record of the passing mental phases of humanity.

The postulates which he claims the science of anthropology should always regard as fixed beyond doubt are: (1) the unity of the anthropologic sciences (in aim, I suppose); and (2) the doctrine of the continuity of the phenomena which it studies. These suggestions from one who understands the field so thoroughly merit careful reflection.

ABOUT THE HITTITES.

THE latest contribution toward an identification of the Hittites with some known stock is from the pen of Professor Fritz Hommel, and is printed in the *Sitzungsberichte* of

the Bohemian Academy of Sciences, 1898, under the title 'Hethiter und Skythen.'

From a thorough study of sources he shows that the Scythians were an Aryan and especially an Iranian folk. It is clear that a portion of them lived in Cilicia and Cappadocia, where other authorities locate the Hittites; and in Mitanni certainly some Aryan blood must have entered, for the Amarna tablets speak of the Mitanni princess as 'blue-eyed.' Also the Amorites were blonde and blue-eyed. To these facts of a physical character Hommel adds a lengthy investigation into proper names, all tending to illustrate a deep Iranian influence in eastern Anatolia. This does not exclude, but much modifies, the 'Alarodian' hypothesis of Sayce and others. Of course, that the Hittites were Aryan has already been asserted by other writers, but not in the form here presented.

D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

The death of Dr. James Hall, which occurred at Echo Hill, Bethlehem, N. H., on August 7th, at the age of eighty-seven years, will cause universal regret among men of science. Since Dr. Hall's return from the International Geological Congress, last year, his health has been failing somewhat, but he fully intended to attend the approaching fiftieth anniversary meeting of the American Association, of which he was one of the founders. It will be remembered that at the meeting of the Association at Buffalo, two years ago, a special session was devoted to appreciations of Dr. Hall's scientific and official work as Geologist of the State of New York for fifty years. Portraits of Dr. Hall were included in the full report that appeared in Science at the time.

Professor Edwin Ray Lankester, Linacre professor of comparative anatomy at Oxford, has been appointed Director of the Natural History Museum, South Kensington, in succession to Sir William Henry Flower.

Professor Mosso, of Turin, has been elected a correspondent of the Paris Academy of Sciences in the section of medicine and surgery. Twenty-six votes were cast for Professor Mosso and ten for Professor Zambaco, of Constantinople.

Dr. Carl I. Cori, of the German University at Prague, has been elected Director of the Zoological Station at Trieste.

Dr. F. J. V. Skiff, Director of the Field Columbian Museum, Chicago, has been appointed Director of Mining and Mineralogy at the Paris Exposition of 1900.

Lord Peel has been appointed a trustee of the British Museum in the place of the late Mr. Spencer Walpole.

It is proposed to erect a bust of Victor Meyer in the chemical laboratory at Heidelberg, and should sufficient money be collected a scholarship for the advancement of chemistry will be established.

The monument to Charcot will be formally unveiled in the Saltpêtrière in Paris on October 23d.

Professor Park Morrill, Chief of the Forecast Division of the Weather Bureau, died at Washington on August 8th of typhoid fever.

The death is announced of Dr. E. B. Aveling, in London, on August 4th, at the age of 47 years. He had been assistant in physiology at Cambridge and professor of chemistry and physiology at New College, and had written on scientific topics, especially in the direction of the popularization of the doctrine of evolution. He was, however, best known as a lecturer and writer on socialism.

M. Paul Sevret, the mathematician, member of the Paris Academy of Sciences, died in Paris on June 24th, aged seventy years.

We regret further to record the death of Professor W. F. R. Suringar, professor of botany in the University of Leyden and Director of the Botanical Garden and Herbarium.

A Fourth International Congress of Agriculture will meet at Lausanne from the 12th to the 17th of September.

Dr. Henry Bessemer has presented to the

British Astronomical Association the observatory erected by the late Sir Henry Bessemer.

MR. BALFOUR, leader of the British House of Commons, recently made an interesting address on the subject of research on the occasion of the distribution of prizes at the medical school of Guy's Hospital, which led a member of the audience to send an anonymous gift of $6,000 for the endowment of medical research.

M. A. GAUDRY recently stated before the Paris Academy of Sciences that Victor Lemoine had bequeathed his valuable paleontological collection to the Paris Museum of Natural History. His widow has given to the Museum the land at Cernay, near Reims, whence the fossils had been obtained.

THE annual meeting of the Corporation and Board of Trustees of the Marine Biological Laboratory was held at Woods Holl, Mass., on August 9, 1898. The report of the Director showed the Laboratory to be in a flourishing condition and the attendance large. The following is a list of the Board of Trustees and the officers for the ensuing year: *President*, H. F. Osborn; *Director*, C. O. Whitman; *Assistant Director*, J. I. Peck; *Secretary*, H. C. Bumpus; *Treasurer*, D. Blakely Hoar. *Trustees*, to serve four years: E. G. Conklin, Camillus G. Kidder, M. M. Metcalf, William Patten, D. P. Penhallow, W. B. Scott. To serve three years: S. F. Clarke, E. G. Gardiner, J. P. McMurrich, L. L. Nunn, H. F. Osborn, E. B. Wilson. To serve two years: William Libbey, W. T. Sedgwick, W. K. Brooks, William Trelease, W. P. Wilson, R. Ramsay Wright. To serve one year: J. H. Macfarlane, F. P. Hall, Jacques Loeb, T. H. Morgan, W. A. Locy.

THE second report of the select committee of the British House of Commons appointed to inquire into the administration and cost of the museums of the Science and Art Department was finally adopted on July 29th by 7 to 3. Perhaps the most important recommendation is to the effect that with a view to the efficient and economical management of the museums in London, to say nothing of other educational advantages not within the order of reference, the committee deem it of paramount importance that there be an Education Minister of Cabinet rank having a seat in the legislature aided by a Parliamentary Secretary. It is recommended that the Geological Museum in Jermyn-street be not occupied as now, but that the collections there exhibited be removed to the west side of Exhibition-road as a science collection.

THE Manitou and Pike's Peak Railroad has arranged to build an observatory on Pike's Peak, but it does not appear at present to be intended to be used for scientific purposes.

THE dedication of the new biological and dairy building at the New York Agricultural Experiment Station at Geneva will take place on or about September 14th.

THE British government has been asked by the Royal Scottish Aboricultural Society for a grant of $200,000 for the establishment of a State Forest near Edinburgh, which it is intended to cultivate according to the methods of modern forestry as an example to landed proprietors. It would also be used for research in forestry.

PROFESSOR BEHRING has secured a patent on the manufacture of diphtheria antitoxin in the United States. This appears to be an unfortunate exception to the moral code which prevents medical men from making monopolies of the remedies they discover. Still it must be remembered that such a patent permits the preparation of the antitoxin under standard conditions and will not of necessity increase the price. The remarks of the medical journals seem rather extreme, as witness the following from the *Medical Record*: "Professor Behring * * * now thinks he is in position, with loaded syringe, to demand of every defenceless babe its money or its life. We do not believe the courts will legalize any such impudent attempt at brigandage."

THE Congress of the Royal Institute of Public Health, under the presidency of Sir Charles Cameron, M.D., is now being held in Dublin. The *British Medical Journal* states that the local preparations are on an extensive scale. The local committee is large and representative, and the subscriptions so far received are generous enough to make it certain that the entertainments will be exceptionally good. The meet-

ings of the various sections take place in Trinity College; the Health Exhibition is held in the buildings of the Royal University, and a banquet in the Royal College of Surgeons. There are four sections—Preventive Medicine and Vital Statistics, Chemistry and Meteorology, Engineering and Building Construction, and Municipal and Parliamentary. In addition, there is a conference of army medical officers on Enteric Fever in the Army, and by medical officers of health on the Housing of the Poor and the Prevention of Tuberculosis. Among the general subjects discussed in the various sections are: The Treatment of Infectious Diseases in General Hospitals, the Increase of Lunacy in Ireland, the Management of the Sick in Workhouse Hospitals, Pollution of Rivers and Treatment of Sewage, and Designing and Construction of Hospitals.

It is announced that the steamship *Valdivia*, with the German deep-sea expedition will leave Hamburg immediately.

Mr. W. C. Andrews, whose expedition to Christmas Island was reported sometime since, is now returning, having made a careful study of the geology of the island and exhaustive collections of its animals and plants.

Fears are entertained in regard to the steamship *Belgica* which sailed for the Antarctic regions last year.

Professor Salisbury, of the University of Chicago, has taken a party of ten students on a geological expedition to the Yellowstone Park.

The London *Times* reports that the government of the Independent State has just sanctioned an important measure for the advancement of scientific knowledge on the Congo. The despatch last spring of the expedition under Lieutenant Lemaire was a commencement in this direction, but, whereas his explorations will be chiefly in the Tanganyika region, the new measure will apply to the whole of the State. Twenty posts which are to form the centers of observation, and also the bases for the collection of flora, fauna and mineralogical specimens, have been decided upon, and are now being carefully organized under the supervision of the proper officers at Brussels. As soon as the posts are in working order a publication will be issued at Brussels for the purpose of recording the results of these experiments. It will be issued every six weeks, under the title of 'Scientific Annals.'

Mr. Akers-Douglas stated recently in the British House of Commons that the Director of Kew Gardens had informed him in April last that volume 4 of the Flora of Tropical Africa was in an advanced state of preparation, but very little of it appears to be yet in type. Two other volumes, Nos. 7 and 5, are being printed first. The third and last part of volume 7 is nearly ready. There have been certain difficulties as to the printing of volume 5, but the publishers have now declared themselves ready to proceed with it.

We learn from *Literature* that Mr. G. Boulger, professor of botany and geology at the City of London College, in addition to his work for the 'Dictionary of National Biography,' in which the Tradescants have occupied him a good deal of late, has been engaged in seeing through the press a new and rewritten edition of the Rev. C. A. Johns' 'Flowers of the Field.' Professor Boulger is also at work upon a new book, a manual on 'Wood' for Mr. Edward Arnold's 'Practical Science Series,' and, in conjunction with Mr. James Britten, he is publishing in *The Journal of Botany*, for subsequent issue in separate form, a supplement to their 'Biographical Index of British and Irish Botanists.'

Messrs. D. C. Heath & Co. announce a book on 'American Indians' by Professor Frederick Starr, of the University of Chicago.

The following regulations have been announced in regard to workers in the Lancashire Sea-Fisheries Hatchery and Laboratory at Piel, Barrow-in-Furness, Lancashire: (1) Biologists and students desiring to work at the Piel Hatchery should apply to the honorary Director (Professor Herdman), who, if there is room, will allot them work places in the Laboratory in the order of application. (2) In the absence of the Director, the Resident Assistant (Mr. Andrew Scott), will determine which places in the Laboratory workers are to occupy, and to what extent the instruments in the Laboratory (microscopes, microtomes, etc.) and the boats and collecting apparatus may be used by workers.

(3) The aquaria in the tank house are intended for experiments in fish hatching and fish rearing, and it is only by express permission of the Director or the Resident Assistant that that they may be used for private investigations. (4) Laboratory accommodation and lodging in the house are given free of charge to those duly qualified workers or students whose applications have been accepted, and who have been assigned a place in the Laboratory. Meals are provided for those working in the Hatchery at at a fixed charge. (5) The Resident Assistant will be ready to give assistance to workers at the Hatchery, and to provide them with material for their investigations so far as it does not interfere with his routine duties and his 'fisheries' work. (6) All dishes, jars, bottles, tubes and other vessels in the Laboratory may be used freely, but must not be taken away from the Laboratory. If any workers desire to make, preserve and take away collections of marine animals and plants they must provide their own bottles and preservatives for the purpose. (7) The fish and other specimens in the tank room are the property of the institution and must not be used or disturbed by workers in the Laboratory. (8) Each worker in the Laboratory is required to send a short account of his work done at the institution, and of the results he has attained, to the Director before the 1st of December (at latest), in order that it may be entered in the Annual Report to the Sea-Fisheries Committee.

AT the summer meeting of the British Institution of Mechanical Engineers, which commenced at Derby on July 26th, Mr. E. Ristori read a paper on aluminum manufacture, with a description of the rolling mills at Milton, Staffordshire. According to the report in the London *Times*, the writer of the paper stated that at the Belfast meeting in 1896 a paper was read which fully described the method adopted for the preparation of pure alumina (oxide of aluminium) from bauxite. Since that time the British Aluminium Company had enlarged their works at Larne, and great improvements had been introduced into the process of manufacture. The finished product was a very finely divided powder, and in order to ship it to Foyers it had been found advisable to pack the alumina in hermetically-sealed steel drums. The oxide was reduced by the Héroult process and the metal run out of the electrolytic baths into ingot moulds. In this form the aluminium was quite pure enough for certain purposes, and much of it was therefore sold without further treatment; but it was not suitable for the production of tubes, rods, etc. The crude ingots were therefore sent to Milton, where they were refined until the metal attained a purity of 99.6 per cent. With certain limitations imposed by the chemical and physical peculiarities of the material, aluminium could be worked much like the other industrial metals handled at the present day. Aluminium could be forged hot or cold, and, in comparison with other metals, it ranked third in order for malleability and sixth for ductility. Sheets had been hammered as thin as one forty-thousandth of an inch. In turning the edge of the tool soon became blunt, and the cutting speed should be high. In its purest form aluminium was very soft, and not of great service in those arts in which much rigidity and strength were required. One casting alloy having a specific gravity of 2.9 was largely used just now, and its composition was still kept secret. It had been found to produce remarkably clean castings which required very little machining to finish up, and it took a high polish. Another alloy contained nothing but aluminium and a small proportion of copper, but it was not one of the materials generally recommended. The two alloys particularly recommended as among the best yet made were both ternary alloys, and next to the aluminium tungsten was the leading ingredient in each. In one of them copper was present to a small extent, and in the other nickel, and both had given astonishing results as regards strength and elongation. Samples of rolled sheets or rods made of these alloys had shown as much as 20 to 22 tons tensile strength per square inch, with 5 to 10 per cent. elongation in four inches. Aluminium bronzes were undoubtedly superior in strength and they were especially suitable for marine engineering. The writer gave a great many illustrations of the uses of aluminium, and, speaking broadly, he said that the metal or one of its light alloys should, to a large

extent, replace copper, tin and nickel. Its use in shipbuilding was growing rapidly.

THE report has been issued as a Parliamentary paper of a visit of inspection made to French matchworks at Aubervilliers, Pantin and Marseilles during June by Dr. Thomas Oliver, of Newcastle, one of the experts appointed by the Home Secretary to inquire into the matter of lead poisoning in the potteries and also into the dangers incidental to lucifer match making. The following are Dr. Oliver's general impressions and deductions: (1) Until recently the match-makers in certain of the French factories suffered severely from phosphorus poisoning; that at the present time there is apparently a reduction in the severer forms of the illness. (2) That the reduction in the amount of illness is attributable to greater care exercised in the selection of the workpeople; raising the age of their admission into the factory; medical examination on entrance; subsequent close supervision; repeated dental examination; personal cleanliness on the part of the workers; early suspension on the appearance of symptoms of ill-health; improved methods of manufacture. (3) That the French government, aware of the dangers of match-making, is furthering, by all possible means, new methods of manufacture, and, with this object in view, retains in its service chemists and inventors who are continually making experiments. (4) That the government has to some extent already succeeded in manufacturing a match capable of striking anywhere, yet free from white phosphorus, but that until now the manufacture of this match is not an industry.

THE London *Times* gave last year an account of some satisfactory tests carried out on wood which, by a process of American origin, had been rendered incombustible, or, at least, incapable of sustaining and conveying flame. It now states that the first works in Europe for the application of this process, erected by the British Non-Flammable Wood Company near the Middlesex end of Wandsworth-bridge, were recently opened, when a number of visitors witnessed another practical demonstration of the enormous power to resist fire possessed by 'non-flammable' wood in comparison with ordinary timber. The process may be said, roughly, to consist of removing the natural juices of the wood and replacing them with certain substances which not only make it fire-proof, but also have antiseptic properties that prevent decay. The operation is effected in retorts or cylinders, the largest of which are 105 feet long by 7 feet in diameter. The wood having been run in on trollies, the air-tight door is closed and the contents subjected to heat and the action of a high vacuum. This treatment is continued till the volatile and fermentable constituents have been withdrawn, the time required to attain this result varying with the character of the wood. The next step is to fill the cylinder with the fire-proofing solution, the exact composition of which is kept secret, and force it into the wood under hydraulic pressure, the amount of which again differs for different woods, but may reach 150 pounds to the square inch or more. When thoroughly impregnated with the salts the timber is taken out of the cylinders, restacked on the trollies, and put into the drying-kiln—a room through which hot air is continually circulated by powerful fans, and which is fitted with apparatus to condense the vapors given off by the wood. Here it remains till it is thoroughly dried—in the case of a load of average thickness about a month. It is then ready for delivery and use. It may be mentioned that the British company claims, as the result of exhaustive experiment, to have improved materially on the original American process by getting rid of certain disadvantages connected with moisture and corrosion.

A SELECT committee of the House of Commons has been appointed to inquire into the working of the telephone service. It appears from testimony given before the committee that, while as a whole Great Britain is in advance of Germany in the use of the telephone, many German cities use the instrument more than cities of the same size in Great Britain. Thus Glasgow, with a population of 656,000, had 7,612 telephone instruments; Cologne, with a population of 292,887, had 4,113 instruments; Liverpool, with a population of 860,000, had 10,935 instruments; and Hamburg, with a population of 573,792, had 13,561 instruments.

to London and Berlin, the population of London within the municipal area was 4,200,000, and there were 25,724 instruments, while in Berlin, with a population of 1,578,794, there were 36,620 instruments.

UNIVERSITY AND EDUCATIONAL NEWS.

THE University of Chicago has established a College for Teachers, which has been endowed by Mrs. Emmons Blaine with $250,000.

PROFESSOR W. LE CONTE STEVENS, of the Rensselaer Polytechnic Institute, has accepted the chair of physics in Washington and Lee University.

DR. CLEVELAND ABBE, JR., has resigned a fellowship in the Teachers College, Columbia University, to accept a chair in Western Maryland College, Westminster, Maryland. Dr. C. C. O'Hara has been elected professor of geology and mineralogy in the South Dakota School of Mines. Mr. Wm. H. Butts and Mr. A. W. Whitney have been appointed instructors in mathematics in the University of Michigan.

DR. ZOGRAF has been elected extraordinary professor of zoology, and Dr. Mrensbier, extraordinary professor of comparative anatomy in the University of Moscow.

DISCUSSION AND CORRESPONDENCE.

OBSERVATIONS ON BLUE JAYS.

TO THE EDITOR OF SCIENCE: The nest of an English sparrow was broken up, and four fledglings, nearly ready to fly, were thrown to the ground. A blue jay seized on one and devoured it. One young sparrow was then placed in the nest of the blue jay—presumably the same—along with its own young, and was tolerated, but not fed, by the parent jays. On the second day, however, I observed the jay once feed, perhaps by mistake, the sparrow. For two days the parent sparrows watched their chance when the old jays were away from the nest and came hastily and fed their sparrow, but not the young jays. On the third day the young sparrow flew away from the jay's nest.

While a single incident can hardly form the basis for generalization, yet, as has been suggested to me, the origin of rites of hospitality may be hinted at here. A blue jay devours a a young sparrow outside its nest, but tolerates and may even adopt the sparrow placed in its nest. Once within the home nest there is a certain hospitality, which biologically means protection to its own young, for the jay might readily acquire a habit of devouring its own young, if the nest-life did not mean protection. We may surmise that the right of hospitality has its biological significance as a home protection act of the greatest service to the species.

The nest was studied through a telescope placed in a window, and as the eye was brougbt within a few inches of the nest without disturbing the birds, a little foliage having been removed, a very close study was possible. The male often turned food over to the female to be given to the young. With one beakful several young were fed, the beak being thrust far down the throat and a portion of the food pinched off, and then another portion pinched off in another's throat. The *excreta* were constantly removed, in one case the parent taking *excreta* directly issuing from the young. The parent sometimes took *excreta* far into the mouth and held it for some minutes. The jay often stands on the nest half brooding, and in full brooding it slips its feet to the bottom of the nest with exceeding deftness. A common warning cry is sharp metallic mouí, mouí, in energetically producing which the jay sways his body up and down, vibrating its perch. In excitement it pecks aimlessly at its perch.

The telescopic method might well be used in getting complete studies of nest life. From a house window, or from a platform in a tree, a continuous study of nesting could be made and experiments tried for instinct and intelligence. Certainly for psychological study the method is invaluable, since it gives the close unhampered observation of expression which is the only key to the mind of the bird. A binocular magnifying about fifty times would be generally convenient, though higher and lower powers would often be useful. Leaves, etc., which screen the nest at the point desired, should be removed at night. A powerful glass might reveal the home life of eagles, vultures and beasts of prey. As

giving a fascinating nearness to animals, unconscious of your spying, the telescope is most serviceable in interesting young people.

HIRAM M. STANLEY.

LAKE FOREST, ILL., August 1, 1898.

SCIENTIFIC LITERATURE.

La certitude logique. Par G. MILHAUD. Paris, Felix Alcan. 1898. Pp. 204.

Those who know what expectations were encouraged by scholastic philosophy would hope for much from a book with the present title, whether it intended to defend or criticise the pretensions that have been associated with the study of logic. The scholastics thought that logic was the source of all certitude in knowledge. The present author's thesis is a denial of this claim. His assertion is that logic cannot give us any certitude beyond particular facts directly observed. This position is based upon the law of contradiction, and the distinction between that which is *given* and that which is *construed*. The author attempts to establish his thesis, first directly, and secondly by an appeal to the testimony of mathematics. In neither of his proofs do I think the author successful in maintaining his position. Not that it is false, but because he has tried to give certitude to a proposition by the very method which he says is incapable of doing it. It is in one aspect of the matter a mere truism that logic cannot give any certitude beyond the facts of individual experience, but is in another relation a very equivocal proposition. It implies that somebody has claimed, or does claim, logic is the source of *all* certitude. In the first place, no one since Descartes has claimed this view. In the second place, all first-class thinkers who have attached any value to logic as a means to certitude of any kind limit it to the proof of doubtful propositions, and do not try to supplant experience of simple facts by it. There is an error on the part of logicians and philosophers here which we had hopes that the author would correct. It is true that much of our psychological analysis and past philosophical speculation gives the impression that ratiocination is the most important and perhaps ultimate process in knowledge, assuming all the while that as a process it was different from the intuitive. But it is possible to show that ratiocination is only one form of intuition, simply that form which serves as a vehicle for the transmission of certitude from one proposition to another, but it is not the primary organ of rectitude. Here was an opportunity for some good discussion of logical processes, but there is no attempt at it. Practically the only reference to logical methods at all is the enunciation of the law of contradiction. The remainder of the work is occupied with discussion upon the application of mathematics to the sciences, and deals with results, not methods. J. H. HYSLOP.

Le rational. Par GASTON MILHAUD. Paris, Felix Alcan. 1898. Pp. 180.

This work is confessedly a supplement to the work on *La certitude logique.* It professes to discuss more fully the rational processes that are supposed to determine logical certitude, but is in most respects subject to the same strictures that we have applied to the former. The author is better acquainted with the material results of the sciences related to his problem than with the issues involved in logical speculation. Only one chapter looks like an approach to the real question, and even this does not exhibit any conception of what the subject demands. The reasoning of mathematics gave the author the intimation of his problem, but he has not studied the formal processes of logic sufficiently to see what they represent. His primary interest is really in the results of the special sciences, and not at all in methodology. The theme is a most important one at the present time, especially as it affords an opportunity to criticise the implications still remaining in general philosophy after the source of them, namely, the old faculty psychology, has passed away. The old distinction between the rational and the perceptive or immediate consciousness which gave rise to the author's problem no longer exists, and we can reconcile logical certitude with all others.

J. H. HYSLOP.

Flore Phanérogamique des Antilles Françaises, Guadeloupe et Martinique. Par le R. P. DUSS, Professeur au Collège de la Basse-Terre. Macon. 1897. 8vo. Pp. xxviii + 656.

The intention of the author has been to furnish a guide to the rich, tropical flora of the French islands, Guadeloupe and Martinique. He has succeeded well in making the work a manual of these insular floras. In addition to this, he has included a large amount of interesting and useful information upon the distribution, phenology, economic value and uses, folk-lore, etc., of the plants of the flora. This task has been accomplished in such a way as to greatly enhance the scientific value of the volume.

The most interesting part to botanists in general is the introduction, which contains a concise account of the phytogeography of the islands. This includes a sketch of the physiography of the islands, of their climate, with especial reference to humidity, and of the zonal distribution of the plants of the flora. The latter, though touched only in its gross features and treated entirely from the floristic instead of the ecologic aspect, is of importance, since it is the first attempt to portray the zonation of the floral covering of a large island. The author distinguishes five zones, or, as he terms them, regions; a use of the term which should be avoided. These zones may be characterized briefly as follows:

I. Maritime zone. This comprises a narrow strip of the sea, characterized by the presence of numerous algæ and by two aquatic monocotyledons, *Ruppia maritima* and *Thalassia testudinum*.

II. Lowland, or coastal zone. This zone begins at the sea level and stretches to the forests at a mean altitude of 500 meters. It is the cultivated zone, and includes four-fifths of the species of the flora. In it may be distinguished eight formations, viz.: (1) Beach; (2) Halophytic woodland; (3) Savannah; (4) Pond and marsh; (5) Rocky hills and slopes; (6) Calcareous hills; (7) Xerophytic coasts; (8) Cultures.

III. Median, or forest zone. A zone of primitive tropical forest extends from a mean elevation of 500 meters to about 800–1000 meters. The lower layers are characterized by the dominance of Aroideæ, terrestrial Orchidaceæ, and species of *Hymenophyllum*, *Trichomanes*, *Lindsaya*, *Asplenium*, *Pteris*, *Polypodium*, *Aspidium*, etc.

IV. Transition zone. This is a narrow stretch, characterized by thickets, marking the transition between the forests and the montane zone.

V. Montane zone. The mountain sides, summits and plateaux possess a floral covering of very sharp delimitation. The shrubs and trees of the two lower zones are replaced by a uniform vegetation of dwarf shrubs and herbs.

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SCIENTIFIC JOURNALS.

WITH the recent appearance of the July number, the *Bulletin of the American Mathematical Society* completes its seventh annual volume. Founded in 1891 as the *Bulletin of the New York Mathematical Society*, it has long been recognized as the most thoroughly representative mathematical journal of the country. The period of its existence has been coincident with the great wave of mathematical productivity which is still sweeping with constantly increasing energy over America. In this movement the American Mathematical Society and with it the *Bulletin* have taken a conspicuous part. It is largely to the members, individually and collectively, of the Society that the movement is due, and its results have been reflected in their organ, the Society's journal. In its list of contributors are found the names of Simon Newcomb, G. W. Hill, Emory McClintock, E. H. Moore, Thomas Craig, B. O. Peirce, H. B. Fine, W. F. Osgood, M. Bôcher, J. Pierpont, H. S. White and nearly every other American mathematician of standing. The *Bulletin* distributes 450 copies of each number to members of the Society, exchanges and subscribers. The volume just completed, Vol. IV., second series, contains 577 pages.

The July number of the *Bulletin* contains, besides the usual 'Notes' and 'New Publications,' the 'Seventh Annual List of Papers Read before the Society and Subsequently Published,' and the index, the following articles and reviews: 'The Structure of the Hypoabelian Groups,' by Dr. L. E. Dickson; 'On the Hamilton Groups,' by Dr. G. A. Miller; 'Note on the Infinitesimal Projective Transformation,' by Professor E. O. Lovett; 'Infinitesimal Transformations of Concentric Conics,' by Professor

E. O. Lovett; 'A Solution of the Biquadratic by Binomial Resolvents,' by Dr. G. P. Starkweather; 'Note on Special Regular Reticulations,' by Professor E. W. Davis; 'Limitations of Greek Arithmetic,' by Mr. H. E. Hawkes; 'Maxima and Minima of Functions of Several Variables,' by Professor James Pierpont; 'On the Intersections of Plane Curves,' by Mr. F. S. Macaulay; 'Elliott's Algebra of Quantities,' by Professor H. S. White; 'Hadamard's Geometry,' by Professor F. Morley; 'Further Note on Euler's Use of i to Represent an Imaginary,' by Professor W. W. Beman; and 'Note on Napier's Rules of Circular Parts,' by Professor E. O. Lovett.

SOCIETIES AND ACADEMIES.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

We have on frequent occasions during the past year called attention to the preparations for the anniversary meeting of the American Association which takes place next week at Boston. We now subjoin the programs of the sections, to which undoubtedly important additions will be made at the time of the meeting.

SECTION A.—MATHEMATICS AND ASTRONOMY.

Address of the Vice-President: Development of Astronomical Photography. By Professor E. E. Barnard, Yerkes Observatory.

1. Three Years' Experience in making Astronomy Popular. By Miss Mary Proctor, New York City.

2. Personal Equations during the Past Century. By Professor Truman H. Safford, Williams College, Williamstown, Mass.

3. Triangles whose Sides and Areas are expressed by Whole Numbers. By Professor Truman H. Safford, Williams College.

4. On Rational Right-Angled Triangles. By Dr. Artemas Martin, U. S. Coast Survey, Washington, D. C.

5. Behavior of the Atmospheres of Gas and Vapor—Generating Globes in Celestial Space. By Dr. J. Woodbridge Davis, Woodbridge School, New York City.

6. Graphical Logic. By Professor Ellen Hayes, Wellesley College, Wellesley, Mass.

7. Illustrations of the Comitant Method of constructing the Imaginary Loci of Analytic Geometry, so as to render their Properties evident to the Eye. By Professor Frank H. Loud, Colorado College, Colorado Springs.

8. The Mass and Moments of Inertia of the Earth's Atmosphere. By Professor R. S. Woodward, Columbia University, New York City.

9. A New Form of Pendulum for measuring the Acceleration of Gravity. By Professor R. S. Woodward, Columbia University.

10. The Gravitation Constant and the Mean Density of the Earth. By Professor R. S. Woodward, Columbia University.

11. The Substitution Groups of Order Fifty. By Dr. G. A. Miller, Cornell University, Ithaca, N. Y.

12. Correction of Local Error in Stellar Photometry. By Henry M. Parkhurst, Brooklyn, N. Y.

13. Variation of Latitude and the Constant of Aberration from Observations at Columbia University Observatory, during the years 1892–1898. By Professors J. K. Rees, Harold Jacoby and Dr. H. S. Davis. Read by Professor J. K. Rees, Columbia University Observatory, New York City.

14. Photographic Researches near the Pole of the Heavens. By Professor Harold Jacoby, Columbia University Observatory.

15. The Parallaxes of 61^1 and 62^2 Cygni from a Reduction of the Rutherfurd Measures. By Dr. H. S. Davis, Columbia Univ. Observatory.

16. The Praesepe Group: Measurement and Reduction of the Rutherfurd Photographs. By Dr. Frank Schlesinger, Columbia University.

17. The Western Boundary Survey of Maryland. By Dr. L. A. Bauer, University of Cincinnati, Cincinnati, Ohio.

18. Linear Algebras. By Professor James Byrnie Shaw, Illinois College, Jacksonville, Ill.

19. A Simple Test as to whether a Continuous Function possesses a Derivative; with Applications to the Examples, hitherto devised, of Continuous Functions having no Derivative. By Professor R. D. Bohannan, Ohio State University, Columbus Ohio.

20. The Relation of Direct and Reflected Observations with Meridian Intruments, and the Interpretation of Results. By Professor J. R. Eastman, U. S. Naval Observatory, Washington, D. C.

21. The Effect of Atmospheric Disturbance on Telescopic Definition. By Professor G. W. Hough, Dearborn Observatory, Evanston, Ill.

22. The Condition of the Surface of the Planet Jupiter. By Professor G. W. Hough, Dearborn Observatory.

23. The Observation of Occultation of Stars by the Moon. By Professor G. W. Hough, Dearborn Observatory.

24. A Class of Functions connected with Kepler's Problem. By Professor Edgar O. Lovett, Princeton University, Princeton, N. J.

25. On the Aims of the International Society for the Promotion of Quaternions and Allied Branches. By Dr. Alexander Macfarlane, Chatham, Ont.

The following reports on recent progress will be presented:

1. Report on the Recent Progress in the Dynamics of Solids and Fluids. By Dr. Ernest W. Brown, Christ's College, Cambridge, Professor of Applied Mathematics, Haverford College, Pa.

2. Report on Theory of Invariants: the Chief Contributions of a Decade. By Professor Henry S. White, Northwestern University, Evanston, Ill.

3. Report on the Recent Progress in the Mathematical Theory of Electricity and Magnetism. By Professor Arthur G. Webster, Clark University, Worcester, Mass.

4. Report on the Modern Group Theory. By Dr. G. A. Miller, Cornell University, Ithaca, N. Y.

5. Meteorology from a Mathematical and Physical Point of View. By Professor Cleveland Abbe, Weather Bureau, Washington, D. C.

SECTION B.—PHYSICS.

Address of the Vice-President: On the Perception of Light and Color. By Professor Frank P. Whitman, Adelbert College, Cleveland, Ohio.

1. The Measurement of Thermal Conductivity in Iron. By Professor E. H. Hall, Cambridge, Mass.

2. On Energy and Entropy.

3. Second Report on the Magnetic Survey of Maryland. By Professor L. A. Bauer, Cincinnati, Ohio.

4. On the Magnetic Deflection of Diffusely Reflected Cathode Rays. By Professor Ernest Merritt, Ithaca, N. Y.

5. On the Electrical Properties of the Vapor from the Arc. By Professor Ernest Merritt and O. M. Stewart, Ithaca, N. Y.

6. The Heat of Fusion of Ice Determined in Electrical Units. By Professor E. L. Nichols, Ithaca, N. Y.

7. The Hysteresis of Iron and Steel at Ordinary Temperatures and at the Temperature of Solid Carbon Dioxide. By A. H. Thiessen, Ithaca, N. Y.

8. The Electrical Resistance of Lead Amalgams at Low Temperatures. By G. W. Gressman, Ithaca, N. Y.

9. The Most Efficient Thickness of Transformer Plate. By F. Bedell, R. M. Klein and T. P. Thompson, Ithaca, N. Y.

10. The Resistance of Iron Wires for Alternating Currents of Ordinary Frequencies. By Professor Ernest Merritt, Ithaca, N. Y.

11. Photographic Studies of the Electric Arc. By N. H. Brown, Ithaca, N. Y.

12. Exhibition of Certain Models in Physics and Dynamics. By Professor Carl Barus, Providence, R. I.

13. Lightning Photographed on Moving Plates.

14. On the Use of the Electrodynamometer instead of the Telephone in Electrolytic Resistance Measurements. By Professor Arthur Kendrick, Terre Haute, Ind.

15. The Structure of Cyclones and Anticyclones.

16. Temperature and Vapor Gradients in the Atmosphere. By Professor F. H. Bigelow, Washington, D. C.

17. On the Velocity of Light in a Magnetic Field. By Edward W. Morley, Henry T. Eddy and Dayton C. Miller.

18. A Study of Standard Meter Scales ruled on Nickel, Silver and Glass. By Professor D. C. Miller, Cleveland, Ohio.

19. An Apparatus for Demonstrating, in Alternating Currents, the Change of Phase due to either Inductance or Capacity.

20. An Apparatus for Determining Coefficients of Induction. By Professor Sidney T. Moreland, Lexington, Va.

21. Study of Elastic Fatigue by the Time Variation of the Logarithmic Decrement. By Professor J. O. Thompson, Amherst, Mass.

22. A Redetermination of the Ampere. By Geo. W. Patterson and Karl E. Guthe, Ann Arbor, Mich.

23. Polarization and Internal Resistance of the Voltaic Cell. By Dr. Karl E. Guthe, Ann Arbor, Mich.

24. A New Gas. By Chas. F. Brush, Cleveland, Ohio.

25. Hysteresis Loss in Iron for very small Ranges of Induction (B). By Henry S. Webb, South Bethlehem, Pa.

26. Note on the Testing of Optical Glass. By Professor W. S. Franklin, South Bethlehem, Pa.

27. A Lecture-room Experiment in Electrostatics. By Professor W. S. Franklin.

28. A Study of Galvanic Polarization. By Barry McNutt, South Bethlehem, Pa.

29. On a Normal Curve of Magnetization of Iron. By S. S. Clark, South Bethlehem, Pa.

30. Some Determinations of Dielectric Strength. By Professor Thomas Gray, Terre Haute, Ind.

SECTION C.—CHEMISTRY.

Tuesday, August 23. (Under the auspices of the American Chemical Society), Morning—Analytical Chemistry, led by Dr. P. DeP. Ricketts, Columbia University. Afternoon—Teaching of Chemistry, Dr. F. P. Venable, University of North Carolina.

Thursday, August 25. Morning—Inorganic Chemistry, led by Dr. H. A. Wells, Yale University. Afternoon—Organic Chemistry, by Dr. Ira Remsen, Johns Hopkins University. Evening—Physical Chemistry, Dr. T. W. Richards, Harvard University.

Friday, August 26. Afternoon (in one of Harvard University rooms) — Physiological Chemistry, led by Dr. E. E. Smith, New York.

Saturday, August 27. Morning—Agricultural Chemistry led by Dr. H. A. Weber, Ohio University. Afternoon—Technical Chemistry, Dr. N. W. Lord, Ohio State University.

SECTION D.—MECHANICAL SCIENCE AND ENGINEERING.

Address of the Vice-President, Professor M. E. Cooley, University of Michigan, Ann Arbor, Mich.

1. High-Speed Influence Machines. By Charles F. Warner, Cambridge, Mass.

2. Proposed Methods of Determining the Frequency of Alternating Currents. By Carl Kinsley, Falls Church, Va.

3. Instruments and Methods of Hydrographic Measurements by the United States Geological Survey. By F. H. Newell, Washington, D. C.

4. The Development of the Topographic Work of the United States Geological Survey and its application to the Solution of Economic and Engineering Problems. By Chas. D. Walcott, Washington, D. C.

5. A new Form of Dynamometer Car. By Professor Lester P. Breckenridge, Urbana, Ill.

6. A Combined Absorption and Transmission Dynamometer. By Professor John J. Flather, Lafayette, Ind.

7. Some Experiments with a New Form of Impact Testing Machine. By Professor W. K. Hatt, Lafayette, Ind.

8. Superheating and the Use of Superheated Steam. By Geo. I. Rockwood, Worcester, Mass.

SECTION E.—GEOLOGY AND GEOGRAPHY.

Address of the Vice-President: Glacial Geology in America. By Professor H. L. Fairchild, University of Rochester, Rochester, N. Y.

1. Outline Map of the Geology of Southern New England. By Professor B. K. Emerson, Amherst, Mass.

2. Basins in Glacial Lake Deltas. By Professor H. L. Fairchild, Rochester, N. Y.

3. An Exhibition of the Rare Gems and Minerals of Mt. Mica. By Dr. A. C. Hamlin, Bangor, Maine.

4. The Hudson River Lobe of the Laurentide Ice-sheet. By Professor C. H. Hitchcock Hanover, N. H.

5. The Age of the Amboy Clay Series as in-

dicated by its Flora. By Professor Arthur Hollick, Columbia University, New York, N. Y.

6. The Origin of the Limonite Ores of Nittany Valley, Pennsylvania. By Professor T. C. Hopkins, State College, Pa.

7. The Region of the Causses in Southern France (with maps and stereopticon views). By Dr. Horace C. Hovey, Newburyport, Mass.

8. The Washington Limestone in Vermont. By Professor C. H. Richardson, Hanover, N. H.

9. Fluctuations of North American Glaciation shown by Interglacial Soils and Fossiliferous Deposits. By Warren Upham, St. Paul, Minn.

10. Time of Erosion of the Upper Mississippi, Minnesota and St. Croix Valleys. By Warren Upham.

11. Supposed 'Corduroy Road' of Late Glacial Age, at Amboy, Ohio. By Professor G. Frederick Wright, Oberlin, Ohio.

SECTION F.—ZOOLOGY.

Address of the Vice President: A Half-century of Evolution with Special Reference to the Effect of Geological Changes on Animal Life. By Professor A. S. Packard, Brown University, Providence, R. I.

1. Evolution and Migration of Hawaiian Land Shells. By Professor Alpheus Hyatt, Boston Society of Natural History, Boston, Mass.

2. A new Classification of Fossil Cephalopods. By Professor Alpheus Hyatt, Boston Society of Natural History.

3. Notes on the Habits of some Burrowing Bees. By Professor John B. Smith, Rutgers College, New Brunswick, N. J.

4. A New Method of Studying Underground Insects. By Professor John B. Smith, Rutgers College.

5. On the Systematic Position of the Trilobites. By Professor A. S. Packard, Brown University, Providence, R. I.

6. On the Carboniferous Fauna of Rhode Island. By Professor A. S. Packard, Brown University.

7. On the Markings of Nodontian Larvæ. By Professor A. S. Packard, Brown University.

8. Some Points in the Oögenesis of *Virbius zostericola* Smith. By Frederic P. Gorham, Providence, R. I.

9. A Species of Myxosporidium found in Fishes, in the Aquaria of the U. S. Fish Commission, at Woods Holl, Mass. By Frederic P. Gorham, Providence, R. I

10. A New Species of Pigment producing Pathogenic Bacillus. By Frederic P. Gorham, Providence, R. I.

11. On the Types of Vertebrate Embryos. By Dr. Charles Sedgwick Minot, Harvard Medical School, Boston, Mass.

12. On the Embryology of the Rabbit. By Dr. Charles Sedgwick Minot, Harvard Medical School.

13. Variation *versus* Heredity. By Professor H. S. Williams, Yale University, New Haven, Conn.

14. The proposed Attempt to introduce *Blastophora psenes* into California. By Dr. L. O. Howard, U. S. Dept. of Agriculture, Washington, D. C.

15. The Records of 1898 of Broods VII and and XVII of *Cicada septendecim*. By C. L. Marlatt, U. S. Dept. of Agriculture, Washington, D. C.

16. On the Genitalia of Ants, and their Value in Classification. By W. H. Ashmead, U. S. Dept. of Agriculture, Washington, D. C.

17. Naples Station: General Description and Notes on Methods of Work employed there. By Dr. E. O. Hovey, American Museum of Natural History, New York, N. Y.

18. General Statement of Types and Figured Specimens of Fossil Invertebrates in the American Museum of Natural History. By Dr. E. O. Hovey, American Museum Natural History.

19. Measurements of two large Lobsters recently added to the Collections of the American Museum of Natural History. By Dr. E. O. Hovey, American Museum Natural History.

20. On the Present State of our Knowledge of the North American Tertiary Mollusk-fauna. By Dr. Wm. H. Dall, Smithsonian Institution, Washington, D. C.

21. Cranial Osteology in certain species of Dinichthys. By Dr. Charles Rochester Eastman, Museum of Comparative Zoology, Cambridge, Mass.

22. Moniloporidæ, a new Family of Palæozoic Corals. By Amadeus W. Grabau, Cambridge, Mass.

23. A Historical Notice of Ross' Rosy Gull,

Rhodostethia rosea. By John Murdoch, Public Library, Boston, Mass.

24. Vein Evolution in Insect Wings. By James G. Needham, Ithaca, N. Y.

25. Localized Stages in Growth. By Dr. Robert T. Jackson, Harvard University, Cambridge, Mass.

26. On the Piscine Ancestors of the Amphibians. By Professor Theo. Gill, Columbian University, Washington, D. C.

27. Variation in the Shell of *Helix nemoralis* in the Lexington, Va., Colony. By Professor Jas. Lewis Howe, Washington and Lee University, Lexington, Va.

SECTION G.—BOTANY.

Address of the Vice-President: The Conception of Species as affected by Recent Investigations on Fungi. By Professor W. G. Farlow, Harvard University, Cambridge, Mass.

1. Studies on North American Lichens. By Thomas A. Williams, Department of Agriculture, Washington, D. C.

2. The Micro-Chemistry of the Cornstalk. By Thomas A. Williams.

3. The Effect of an Atmosphere of Ether upon Seeds and Spores. By C. O. Townsend, Barnard College, New York City.

4. Half Shade and Vegetation. By Byron D. Halsted, New Jersey Agricultural Experimental Station, New Brunswick, N. J.

5. Influence of a Wet Spring on Parasitic Fungi. By Byron D. Halsted.

6. Starch Distribution as affected by Fungi. By Byron D. Halsted.

7. The Carposporic Type of Reproduction of Rhodophyceæ. By Bradley M. Davis, University of Chicago, Chicago, Ill.

8. Notes on the Relative Infrequency of Fungi upon the Trans-Missouri Plains and the Adjacent Foothills of the Rocky Mountains. By Charles E. Bessey, University of Nebraska, Lincoln, Neb.

9. The Comparative Anatomy of the Pistils of Apocarpous Families. By Ernest A. Bessey.

10. Origin and Homologies of Blepharoplasts. By Herbert J. Weber, Dep. Agric., Washington, D. C.

11. Notes on the Strand Flora of Florida (lantern slide lecture). By Henry J. Weber.

12. Some Misuses of the Herbarium. By E. L. Greene, Catholic University of America, Washington, D. C.

13. The Advantages offered by the Philadelphia Commercial Museum to Botanists. By Wm. P. Wilson, Director, Philadelphia, Pa.

14. Notes on Arctic Willows. By W. W. Rowlee, Cornell University, Ithaca, N. Y.

15. On the Hypocotyl of Woody Dicotyledonous Plants. By Francis Ramaly, University of Colorado, Boulder, Col.

16. The Quantitative Analysis of the Floral Covering. By Roscoe Pound and Frederic E. Clements, University of Nebraska.

17. Some Investigations bearing upon the Symbiotic Microplasm Theory of Grain Rust. By Henry L. Bolley, North Dakota Experimental Station, Fargo, N. Dakota.

18. The Work performed by the Agricultural College toward a Botanical Survey of Michigan. By W. J. Beal, Agricultural College, Ingham Co., Michigan.

19. Some Examples Illustrating Modes of Seed Dispersion. By W. J. Beal.

20. Notes on the Physiology of the Sporophyte of Certain Mosses. By Rodney H. True, Wingra Park, Madison, Wis.

21. The Toxic Action of a Certain Group of Compounds. By Rodney H. True.

22. Types of Vegetation on the Keys of South Florida. By Charles Louis Pollard, Washington, D. C.

23. On the Validity of the Genera *Senna* and *Chamæcrista*. By Charles Louis Pollard, National Museum, Washington, D. C.

24. Species Characters among the Violets. By Charles Louis Pollard.

25. Potato as a Culture Medium, with some Notes on a Synthesized Substitute. By Erwin F. Smith, Department of Agriculture, Washington, D. C.

26. Some Little-used Culture Media which have proved Valuable for Species Differentiation. By Erwin F. Smith.

27. Plant Growth in Terms of Climatology. By Milton Whitney and Lyman J. Briggs, Department of Agriculture, Washington, D. C.

28. Effect of Fertilizers on the Germination of Seeds. By Gilbert H. Hicks, Department of Agriculture, Washington, D. C.

29. Development of the Pollen Grain in *Symplocarpus* and *Peltandra*. By B. M. Duggar, Cornell University, Ithaca, N. Y.

30. Fermentation without Live Yeast Cells. By Katherine E. Golden, Lafayette, Ind., and Carleton G. Ferris.

31. Deterrent Action of Salt in Yeast Fermentation. By Katherine E. Golden.

32. Fungous Gardening as practiced by the Termites in West Africa and Java. By O. F. Cook, U. S. National Museum, and D. G. Fairchild, Department of Agriculture, Washington, D. C.

33. The Embryology of *Taxus*. By E. J. Durand, Cornell University, Ithaca, N. Y.

34. A Bacteriological Study of Pear Blight. By Lillian Snyder, Lafayette, Ind.

35. Life History and Characteristics of the Pear Blight Bacillus. By Merton B. Waite, U. S. Department of Agriculture.

36. Notes on Some Diseases of Southern Pines. By Hermann von Schrenk, Missouri Botanic Garden, St. Louis, Mo.

37. The Ecological Distribution of Colorado and Wyoming Plants. By L. H. Pammel, Ames, Ia.

38. Notes on Some Monocotyledonous Embryo-sacs. By K. M. Wiegand, Cornell University, Ithaca, N. Y.

39. General Characteristics of the Dune Flora of Southeastern Virginia. By Thos. H. Kearney, Jr., U. S. Department of Agriculture, Washington, D. C.

40. Vegetation of the Wooded Fresh-water Swamps of Southeastern Virginia. By Thos. H. Kearney, Jr.

SECTION H.—ANTHROPOLOGY.

Address of the Vice-President: The Advance of Psychology. By Professor J. McKeen Cattell, Columbia University, New York.

1. Typological Analysis. By Professor D. G. Brinton, University of Pennsylvania.

2. Anthropological Terminology. By Professor D. G. Brinton.

3. Sophiology, or the Science of the Evolution of Opinion. By Major J. W. Powell, Bureau of American Ethnology, Washington, D. C.

4. Papago Medicine. By Dr. W J McGee, Bureau of American Ethnology, Washington, D. C.

5. Some Definitions in Anthropology. By Dr. W J McGee.

6. Anthropological Problems of the Pacific Slope. By Dr. W. H. Holmes, U. S. National Museum.

7. Museum Presentation of Anthropology. By Dr. W. H. Holmes.

8. The Significance of the Garment, a Study of the Omaha Tribe. (Lantern illustrations.) By Miss Alice C. Fletcher, Washington, D. C.

9. The Earth Lodge. By Miss Alice C. Fletcher and Dr. W. Matthews, Washington, D.C.

10. The Harmonic Structure of Indian Songs. By Professor J. C. Fillmore, Pomona College, Claremont, California.

11. Ritual of the Sacred Pole of the Omahas. (Phonograph records.) By Francis La Flesche, Washington, D. C.

12. The Survival of African Music in America. By Mrs. Jeanette Robinson Murphy, New York, N. Y.

13. Some of the Evidences that Northmen were in Massachusetts in pre-Columbian Times. By Miss Cornelia Horsford, Cambridge, Mass.

14, 15. Subjects relating to the Physical Anthropology of North American Indians. By Dr. G. A. Dorsey, Field Columbian Museum, Chicago, Ill.

16. The Smith Sound Eskimo. By A. L. Kroeber, Columbia University.

17. The Maori of New Zealand; his history and country. By Hon. Hugh H. Lusk, England.

18. 'Moros,' or Malay Pirates of the Southern Philippines. By Professor Dean C. Worcester, University of Michigan, Ann Arbor, Mich.

19. The Philippine Islands and their People. By Professor Dean C. Worcester.

20. The Tools of the American Pioneer. (Lantern illustrations.) By H. C. Mercer, University of Pennsylvania, Philadelphia, Pa.

21. The Origin of Domesticated Animals. By H. C. Mercer.

22. Burial Customs of the Ancient Zapotecans of Southern Mexico. By M. H. Saville, American Museum of Natural History, New York.

23. Notes on the Lacandon Indians of Mexico. By M. H. Saville.

24. Tomahawk and Shield. By Frank H.

Cushing, Bureau of American Ethnology, Washington, D. C.

25. Examples of Primitive Fire-working from Florida. By Frank H. Cushing.

26. Art in Prehistoric Times. By Professor Thomas Wilson, Smithsonian Institution, Washington, D. C.

27. Prehistoric Musical Instruments. By Professor Thomas Wilson.

28. Arrow-points, Spear-heads and Knives. By Professor Thomas Wilson.

29. Problems of the Rechahecrian Indians of Virginia. By William Wallace Tooker, Sag Harbor, N. Y.

30. The Swastica and other Marks among the Eastern Algonquians, a preliminary study. By William Wallace Tooker.

31. The Water Burial Time. By Stansbury Hagar, New York.

32. Relation of the Moon to Time-reckoning among the Early Races. By R. J. Floody, S. Ashburnham, Mass.

33. The Rite of Circumcision among the Early Races. By R. J. Floody.

34. Anthropology, not Sociology, as an Adequate Philosophy. By Daniel Folkmar, Milwaukee, Wis.

35. Science the Basis of Morals. By M. A. Clancey, Clerk's Office, Supreme Court, Washington. D. C.

36. Anthropological Differences between Typical White and Negro Girls of the same Age. By Dr. A. Hrdlicka, State Pathological Institute, New York.

37. Variations of the Normal Tibia. By Dr. A. Hrdlicka.

38. Résumé of Recent Studies on the Origins of European Races. By Dr. W. Z. Ripley, Massachusetts Institute of Technology, Boston, Mass.

39. Presentation of a Bibliography of the Anthropology and Ethnology of Europe. By Dr. W. Z. Ripley.

40. Typical American Students, illustrated by Charts and Statues. By Dr. D. A. Sargent, Hemenway Gymnasium, Harvard University, Cambridge, Mass.

41. A New Kymographion; a New Chronoscope. Professor G. W. Fitz, Harvard University, Cambridge Mass.

42. Anthropometric Instruments. By Professor J. McKeen Cattell, Columbia University, New York.

43. Psychology and Art. By Professor Hugo Münsterberg, Harvard University, Cambridge, Mass.

44. The New Theory of the Light Sense. By Mrs. C. Ladd Franklin, Baltimore, Md.

45. Discussion: In Man, what Factors are due to Heredity and what to Environment? Opened by Professor D. G. Brinton, Dr. W J McGee and Dr. W. Z. Ripley.

SECTION I.—SOCIAL AND ECONOMIC SCIENCE.

Address of the Vice-President: The Historic Method in Economics. By Archibald Blue, Director, Bureau of Mines, Toronto, Ontario.

1. The College of Forestry at Cornell University. By B. E. Fernow, Cornell University, Ithaca, N. Y.

2. High Wages in Money or what Money will buy, the Consequent of Low Cost of Production. By Edward Atkinson, Boston, Mass.

3. Local Life by Local Times. By S. Edward Warren, Newton, Mass.

4. A Study of Competition and Suburban Prices. By S. Edward Warren.

5. Executive Discretion in the United States. By Cora A. Benneson, Cambridge, Mass.

6. The Short Duration of School Attendance, Causes and Remedies. By Mr. and Mrs. Daniel Folkmar, State Normal School, Milwaukee, Wis.

7. The Progress of the Maritime Commerce of the World during the past Fifty Years. By E. L. Corthell, New York, N. Y.

8. Cuba, Past, Present and Future. By Wolford Nelson.

9. Examination of the Theory of Rent. By Edward T. Peters, Washington, D. C.

10. The Price of Wool. By Henry Farquhar, Department of Agriculture, Washington, D. C.

11. The Transportation Problem. By John S. Willison.

12. The Formative Period of a Great City: A Study of Greater New York. By William H. Hale, Brooklyn, N. Y.

13. Deviations from the Normal in the Annual Rate of Agricultural Production. By John Hyde, U. S. Department of Agriculture.

14. Competition and Railway Rates. By H. T. Newcomb, Department of Agriculture.